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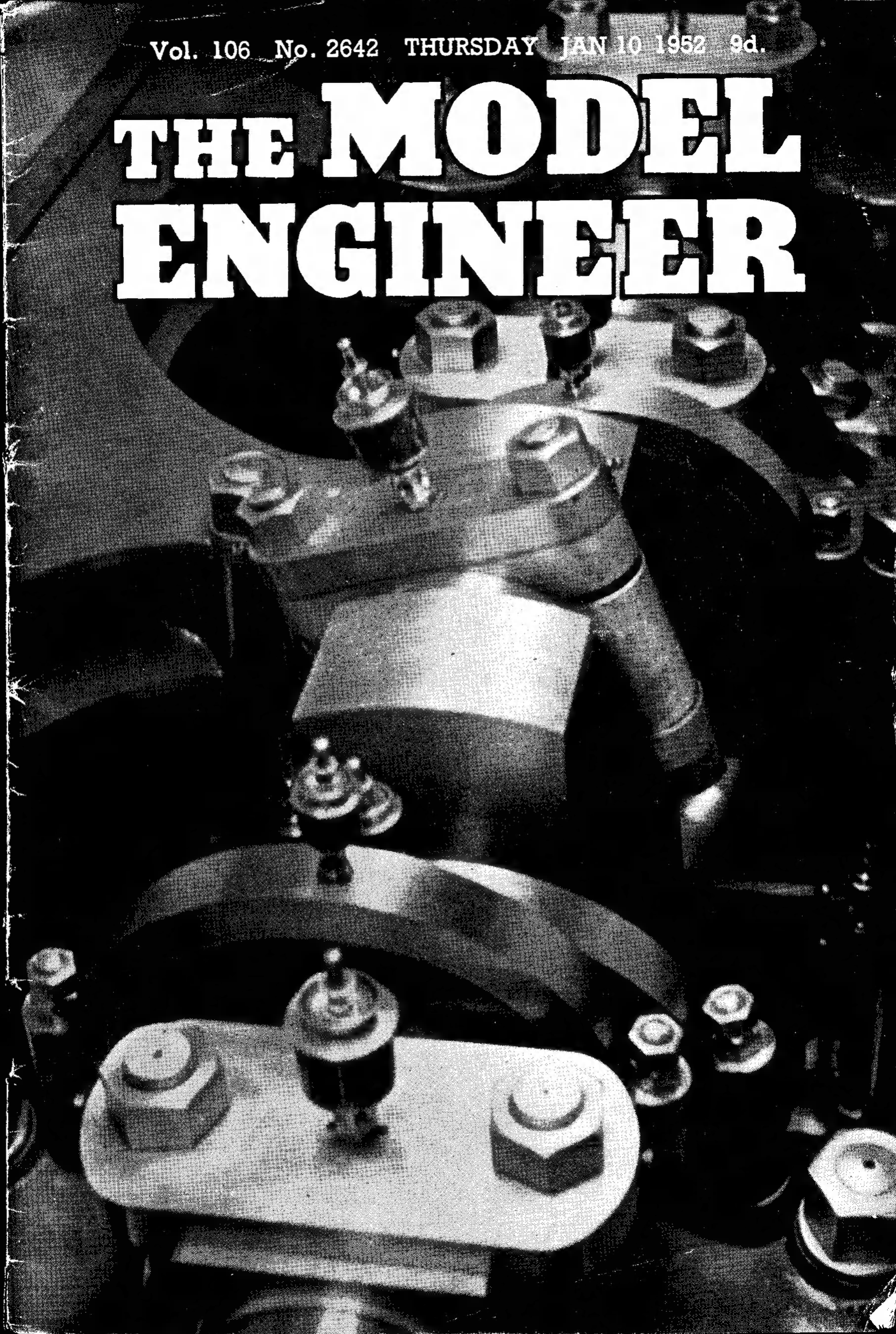
THE MODEL ENGINEER



The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

10TH JANUARY 1952 VOL. 106 NO. 2642

SMOKE RINGS

Our Cover Picture

● THIS PHOTOGRAPH, submitted by Mr. A. R. Turpin, was taken in the engine room of one of the paddle steamers plying on the Lake of Thun, Switzerland. It depicts the cranks and valve eccentrics of the direct-acting paddle engines used in these boats. Mr. Turpin remarks that one of the engines was dated 1899, but was in immaculate condition, and looked as if it had just come from the shops.

Thank You!

● IT IS our pleasant duty, once more, to return thanks to all those kind readers who sent us Christmas greetings and New Year wishes. Cards and letters reached us from many places in Britain, Denmark, Germany, Belgium, France, Spain, Asia, Africa, America, Canada, Australia, New Zealand, India and Ceylon. All these are gratefully acknowledged and their messages cordially reciprocated.

Clearly, THE MODEL ENGINEER is circulating all over the world, and the majority of readers near and far, look upon it as something personal. One of the cards from America—actually from Cadillac, Michigan—bore a message which epitomises them all; it read: "This is for all who make possible THE MODEL ENGINEER. Truly a great magazine—words cannot express my appreciation, but you folk will understand."

We *do* understand, but we do not know a language containing words in which to frame a fitting reply. The tonic effect is wonderful, though somehow we feel it but a lame effort merely to answer: "Thank you"!

Radio Pioneers

● THE RECENT commemoration of the 50th anniversary of the first Transatlantic wireless messages by Marconi has aroused a good deal of correspondence on the subject of early experiments in this branch of electrical science. It will be recalled that the very first issue of THE MODEL ENGINEER, in 1898, contained an article on the construction of a wireless transmitter and receiver, and the claim that this was the first constructional article on the subject ever published has so far remained unchallenged. In the early years of this century, many well-known wireless pioneers contributed articles to THE MODEL ENGINEER, including Mr. R. P. Howgrave-Graham, whose articles on high-voltage high-frequency apparatus for wireless, X-rays, and cathode ray generators started many amateurs working on this fascinating line of research; also, Captain Quentin Cranford,

R.N., whose early work on radio telephony, culminating in the classic experimental transmission in 1907 from H.M.S. *Andromeda*, which startled and mystified many listeners, undoubtedly laid the foundations of modern systems of broadcasting. In view of the keen interest taken in the subject of wireless—the modern term "radio" is, we believe, of Transatlantic origin—by readers of THE MODEL ENGINEER in those days, we have often been asked why this subject is no longer dealt with to any great extent in these pages. The answer is that it has now become a highly specialised subject, and that there are several technical journals devoted exclusively to it, or to its allied branches of electronics. When broadcasting first began in 1922, the late Mr. Percival Marshall recognised the importance of promoting knowledge on this subject, and founded a monthly journal devoted to the experimental aspect of wireless, which was later taken over by another well-known publisher and is, we believe, still flourishing.

Get Weaving!

● MR. W. G. FIELD, author of the article under the above title, informs us that Mr. Norman Jones was responsible for assisting him with the instructions on weaving and patterns which appeared in last week's issue of THE MODEL ENGINEER. He wishes gratefully to acknowledge Mr. Jones's co-operation.

No More "Bulldogs"

● AMONG THE well-known locomotive classes that have become extinct during the last twelve months, the former "Bulldogs" of the Great Western Railway must be included. In "Smoke Rings" for August 16th last, we recorded that only two of these engines were then in existence; that note had been written a few weeks before, and since that date, both engines, *Seagull* and *Skylark*, had been working local goods traffic in the Reading area. In October, however, they ran their last trips—to Swindon and the scrap-heap.

The Western Region of British Railways will seem strange without its "Bulldogs," for the class, which originally consisted of 156 engines, was scattered all over the system and was known to practically every locomotive enthusiast who has journeyed over G.W.R. metals during the last 50 years.

In their time, these engines have worked every kind of traffic, ranging from the Cornish Riviera Express—on which they were, at one time, to be seen regularly, west of Plymouth—to local pick-up goods trains. In spite of their 5 ft. 8 in. coupled wheels, they were capable of attaining and sustaining high speed on long stretches of favourable road, and they could haul really heavy loads when called upon to do so.

Their construction extended over a period of ten years, and their average "life" amounted to more than 40 years; so the engines may be said to have earned their cost and paid a handsome return. They were always great favourites and could be trusted to give reliable service on whatever work they were put to.

The Talyllyn Railway

● WE HAVE received a copy of a report of the annual general meeting of the Talyllyn Railway Preservation Society, a body which, as reported in the "M.E." for March 15th last, was formed to take over the ownership and administration of the Talyllyn Railway, so as to preserve the oldest steam-hauled, passenger-carrying, narrow-gauge railway in the world.

The society operates on a non-profit-making basis, and we are pleased to see that, since the formation of the society in October, 1950, considerable success has attended its efforts, in spite of difficulties. The most urgent matter is the repair of the track, and much yet remains to be done; but the line was opened for limited traffic on May 14th, 1951, and a five-day-a-week service was run during the summer. During the present winter, more track repairs are in hand, with a view to extending the service in future.

Meanwhile, the two derelict steam locomotives of the former Corris Railway have been acquired and, on inspection, found to be in good condition, subject to certain repairs. The Chief Mechanical Engineer, Mr. David Curwen, spent much of the past summer keeping the surviving Talyllyn engine No. 2, *Dolgoch*, in working order, since this historic 85-year-old locomotive bore the brunt of the season's traffic!

To enable the society to attain its full objectives, at least another £5,000 must be raised. More members are therefore wanted; the scheme should make a strong appeal to railway enthusiasts everywhere, and they can obtain full particulars of membership from the secretary, P. B. Whitehouse, 344, Lordswood Road, Harborne, Birmingham, 17.

Not What He Thought It Was

● AIRCRAFTSMAN P. P. ANDERSON, writing from Preston, states that when on leave recently, he was travelling along the main Worthing-London road and had just passed the "Burrell Arms" at West Grinstead when he noticed an interesting-looking canopy in a yard beside a blacksmith's shop. On going to investigate, he found, not what he thought, but what he describes as something that "appeared to be an oil-engined ploughing engine, but not one of the 'cannibalised' Fowler type. It had a girder chassis with normal traction wheels, about 4 ft. 6 in. diameter and straked at the rear and about 2 ft. diameter smooth in front. Steering was by spud-pan and chains, and the power unit was apparently of about eight litres capacity, with a radiator of the pattern familiar on early Ruston excavators. Owing to darkness, I could not see if the engine was for oil or petrol, but there was a strong smell of paraffin around it. Behind the engine was the driver's platform, and at the rear end of this a large winding drum was mounted vertically, with the usual guide pulleys under the platform. The only nameplate I could find was partly defaced and read:—ARRET'S PATENT MECHANICAL WINDLASS. Could this be 'Garret'?"

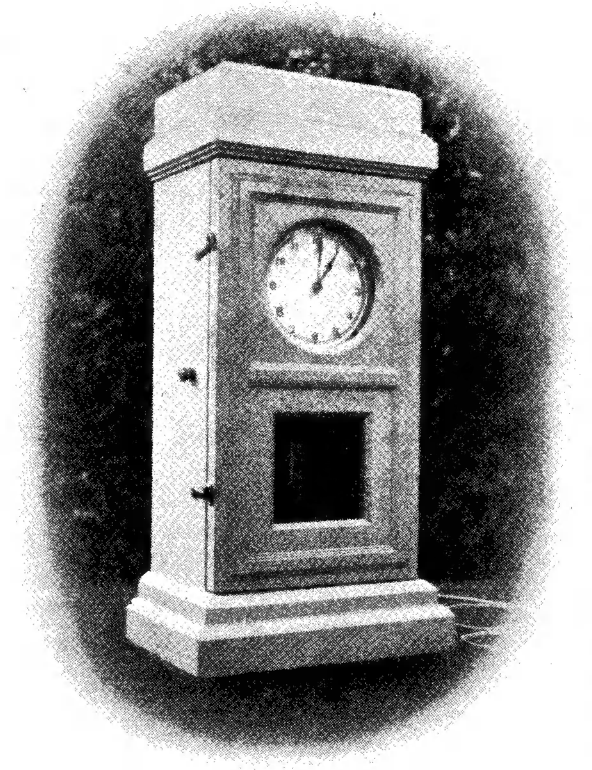
Mr. Anderson also mentions that, up to the middle of November, there was one of those queer Robey rollers working near Leigh, Lancs.

BEDROOM HOROLOGY !

H. G. Sharp, of Argentina, describes an electric clock embodying several novel features

THIS is an introduction to a ½-sec. clock, standing 17.5 in. high, with a body 6.75 × 4.5 in. It was intended for use in a day-room but as no mahogany was procurable and the cedar wood of which the case is made could not be brought to a satisfactory appearance, it was painted white and relegated to a bedroom. It originally had a commercial aluminium face, but this was replaced by a celluloid dial, home-made.

What is the use a bedroom clock which cannot be read at night? So lighting was provided.



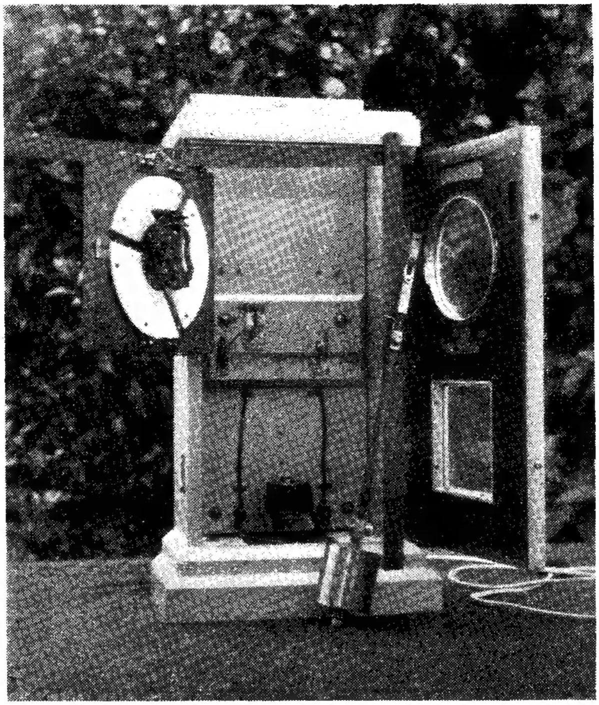
From the photographs it can be seen that the driving ratchet is attached to a length of wire (piano) which can oscillate on a bearing provided at its lower extremity. Two detents are provided which prevent this arm falling to one side when the clock is opened. I am sorry to see that I did not notice that I had pushed the ratchet off the wheel before taking the photograph.

The pendulum-rod is of walnut wood, very old, and is square in section. Its lower end was turned round and inserted into a piece of brass rod bored out to receive it, into which it was glued and pinned. This rod was fine threaded for the pendulum adjusting-screw and bored and threaded to take the piece of soft-iron which acts as armature. Pieces of brass tube—commercial product—a sliding fit on the rod, carry the steel inclined plane, fand a fork leading into a slot which engages the wire carrying the driving ratchet. The rod terminates in a piece of the brass tube in which it is secured. This piece is capped to take the suspension spring, the middle third of which is cut out, and this is soldered into a brass terminal traversed by a short pin which rests on the suspension cock. The flat terminal is a sliding fit in a slot cut in the cock which has a clamping-screw.

The sliders on the rod are fitted with clamping-screws with brass pads between them and the rod. Movement of the upper slider regulates the travel of the driving ratchet.

A length of the brass tube was silver-soldered into a square hole in the centre of a brass disc. The tube was centred in the lathe and the disc faced both sides and turned to a close fit in a piece of thin-walled brass tube, a second disc was made to fit easily over the square tube and into the exterior one which forms the vertical wall of the pendulum-bob. The three pieces were assembled and the lower disc secured in place with screws. Molten lead was run into the bob to overflowing, this was put in the lathe, the lead faced off and the top disc put on.

The trigger is a bit of clock spring with the greater part of the sides ground off to reduce weight. The contact-lever is of light channel section brass and is tapered off from the trigger bearing, to one end on which is soldered a large platinum point. The other end of the lever has a counterweight which almost balances the assembly. The other contact point is mounted on an arm of a bell crank, the other arm of which acts as a detent. The contact arm was weighted —by trial—until satisfactory electrical contact



was assured. In action, a certain amount of rubbing takes place between the contacts, and this appears to maintain good contact, as the platinums never require cleaning. When working, the lift given to the upper contact is very small, 1/50 in. is enough.

The flex carries 220 V, a.c., to a small 4.8 12 V bell transformer placed in the base of the clock. On either side of it is a heavy shaped lead weight giving stability to the clock. The electromagnet is made of a short piece of iron wound for saturation, taking into account that the current is a.c. —12 is the voltage used.

The ratchet wheel is bossed and mounted on an extension of the spindle of the correct cogwheel of the alarm clock mechanism. A bit of steel wire was deep bored to receive the cog-wheel spindle, the other end being reduced to form a bearing. With one in the s.c. chuck and the other in the tailstock, both were soldered together. The bearing hole in the backplate of the clock was bored out to admit the extension, and a bearing plate fitted to the end of the extension. The hole in the backplate was then further enlarged to prevent possible binding. The boss of the ratchet wheel was then pinned to the extension. The ratchet wheel has 57 teeth; these were marked off in the lathe and formed with jeweller's saw and file; the appearance is dreadful but the result is excellent.

The illumination of the dial was an afterthought. The brass plates visible top and bottom of the wood flap were screwed to similar plates on the front of the flap. The plates were then removed and enough wood cut away to allow of the passage of 2 V lamp bulbs. These bulbs are in series and get current from the 4 V terminals of the transformer. The switch knob can be seen at the side of the clock case. The wooden flap had to be bored out to nearly the full diameter of the dial, and arms fitted to the alarm clock mechanism. The white segmental-pieces are of celluloid backed with silver paper; their object is to keep the inside of the clock as dark as possible. The divisions of the dial are in black enamel, the numbers in indian ink. It was difficult to make either the enamel or the ink take on the celluloid, so the result is not good.

All the pendulum mechanism is mounted on a board which is screwed to the back of the case. The amplitude of oscillation measured at the extreme end of the rod barely exceeds 1-in., so so the clock is fairly silent. A much shorter and larger diameter bob would be an improvement, as the trigger assembly could then be lowered and the length of oscillation reduced.

This is the second of two rather similar cocks, and it can be said that both are excellent timekeepers.

For the Bookshelf

Electric Lighting by C. E. Gimson, M.Sc. (Eng.). (Cleaver Hume Press Ltd., 42a, South Audley Street, London, W.1.) Price 9s. 6d. net.

Effective lighting plays an important part in the model engineer's workshop, and this book will do much to assist the amateur in deciding to what extent he should concentrate on the problems of illumination.

The author makes no claim that it should be considered as an authoritative work, his aims being mainly to establish a balance between light sources and lighting principles. This he fulfils, with the aid of innumerable line and half-tone illustrations, in a manner easily assimilable by both layman and student.

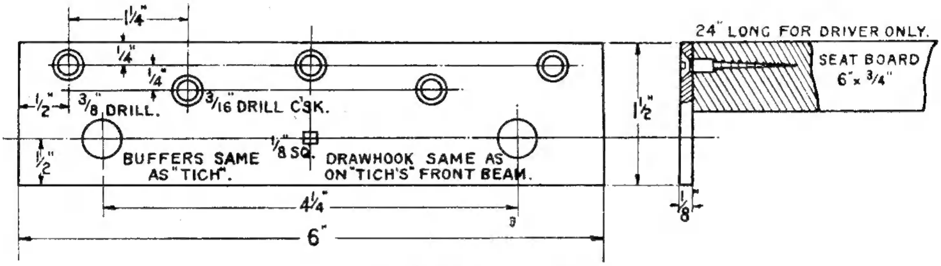
Electric Lighting will undoubtedly prove a most worthy addition to the Cleaver Hume Electrical Series, in which it is No. 7.

"L.B.S.C.'s" Beginners' Corner

Brake Operating Gear for "Tich" Car

BY the good rights I should have carried on with the instructions for *Britannia's* cylinders this week, but I haven't finished the drawings ; open confession, they say, is good for the soul. Eh? goodness gracious, don't run away with that idea—I'm quite well, thank you, except for feeling terribly tired nowadays ; neither have I developed a fit of laziness ! Well, to tell you the honest truth, our worthy friend the Book Editor piled the proofs of the new *Maisie* book on to me, for revision and correction ; there are nearly fifty printed sheets, over a hundred line drawings, and about a score of photographs to check and correlate. A lot has had to be rewritten, to bring it up to date ; Percival Marshall & Co. Ltd. would be the last firm in the world, to offer to their readers a lot of hashed-up out-of-date matter, and your humble servant feels the same way about it. Prospective purchasers of the *Maisie* book will find details of the new fast-steaming high-superheat boiler in it, and other improvements, so that the engines built to the given instructions, will be as far in advance of the original engine, as the Gresley rebuilds were ahead of the original "Ivatts." The latter were good—so was the original *Maisie*—but there is nothing so good in this world that it cannot be improved ; 'nuff sed !

At the time of writing, the job is nearly done, and I hope to get on with the *Britannia* drawings in a few days ; meanwhile, I already had some in hand for the little *Tich* driving car, so our beginner friends will reap the benefit. By the way, this little car seems to be "just what the doctor ordered," not only for beginners, but builders of much more elaborate locomotives as well, judging from correspondence received. For anybody who wants to sit up as close as possible to the back of a locomotive with a long tender, bringing the handles on the footplate within easy reach, it is just the berries. Querists want to know if the bogies, as described, can be placed under a longer seatboard, to carry two or three passengers. It would be all in order to use a four-foot board, to carry two adults or three kiddies, but I shouldn't advise anything longer. Even in that case, the springs should be made of 16-gauge wire, to carry the extra load. Well, let's get on with the job.



Buffer-beam details

Seatboard and Buffer-beams

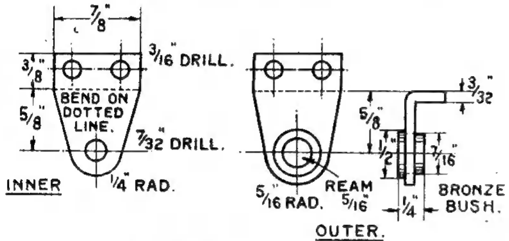
The seatboard should be made of some kind of wood that is not liable to warp and twist on the slightest provocation. I'm not an expert in "woodology," so cannot recommend any particular kind ; all I can tell you is, that two of my cars have teak seat-boards, and they are as flat now, as when first made. One of my few personal friends, per contra, has a hardwood one (I don't know what kind) which goes "all over the shop" in a manner of speaking, every time the weather changes. For the single-seat car, the piece should be two feet long and six inches wide, with a thickness of ¾ in. My little pet "Lady Godiva" car has a small rubber mat fixed on it, which is a good "clothes-preserver." I tried sponge-rubber on one of the cars some years ago, but found that the springiness of the rubber seemed to upset my balance, and found I could ride the car ever so much better on the "solid" seat. Those good folk who ride astride, might find the sponge rubber best for their anatomies.

The board should be planed off smooth and square at each end. The buffer-beams are two 6 in. lengths of 1½ in. × ⅛ in. mild-steel, drilled as shown in the illustration, and attached to the ends of the seatboard by 1¼ in. countersunk-head wood screws. If the wood is very hard, holes must be drilled for the screws, and a smear of grease (ordinary motor grease will do) helps them to go in easily.

The buffers can be made to the instructions given for those on *Tich* ; but here is a tip. If the railway on which the car is to run, has sharp curves, it would be a good wheeze to make the heads larger in diameter, say 1¼ in. which will prevent buffer-locking on curves. Full-size locomotives and wagons have far less side move-

ment in proportion to small ones, yet we used to get plenty of buffer-locking when shunting wagons in goods yards where the curves were sharp; and it was a job involving much jerry-wangling, plus plenty of railroad Esperanto, to get them unstuck again. If the small buffers locked when running around a curve, it would probably throw the train off the road when you came into the straight again. Prevention is always better than cure! The buffers are attached to the beam by nuts, same as on the engine.

The same kind of drawbar hooks, as used on *Tich*, can be used for the car. The leading one should be fixed in the same way as *Tich's*, as there is no room for a projecting spindle, owing to the brake shaft bracket being in the way. However, the long spindle and spring, can be used for the rear beam, same as on the engine. A longer coupling chain will be needed. With the buffers fully extended, and just touching, on a straight bit of line, the distance between the beams, on the engine and car, will be approximately 2¾ in.; and to allow for, say, ⅛ in. gap on the straight, so that the buffers will not be compressed too much on a curve, the chain should be approximately 1⅞ in. long. Too much compression on the buffers, will force the wheel flanges against the railhead; and they would climb over it and upset the whole apple-cart at the slightest provocation, such as a wide rail-joint or a low place.



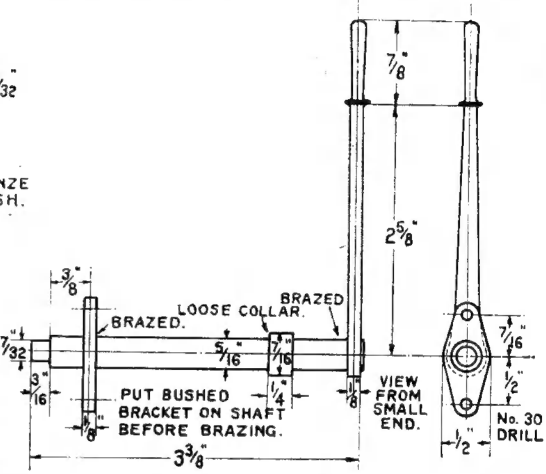
Brake shaft bearings

How to Erect the Bogies

This is a simple job. Just take the bolsters off the bogies, lay the seat-board upside down on the bench, and put the bolsters on it in such a position, that the bogie-pins are dead on the centre-line of the board, and 6 in. from each buffer-beam. The bolsters should lie perfectly square across the board; you can ensure this by applying a try-square with its stock against the edge of the board and the blade against the edges of the vertical sides of the bolster. Each is attached by three ⅝-in. woodscrews (round-head) each side, as shown in the bolster flanges in the general arrangement drawing given with the first instalment. Alternatively, $\frac{3}{16}$ in. countersunk-head metal screws can be put through drilled and countersunk holes in the seatboard, and nutted underneath, spring washers being put under the nuts, between them and the bolster flanges. Small flat-headed coach bolts can also be used; as a matter of fact, I would recommend these if the board is of soft wood.

Brake Shaft Assembly

The bearings for the brake shaft are cut from 3/32 in. soft mild-steel sheet, and bent to shape, all dimensions being given in the illustration. Note that the two bearings differ. One has only a plain drilled hole in it, to carry the spigot at the end of the brake shaft. The wear is practically negligible, as the movement of the shaft is so small, and there is very little pressure on it, so the plain hole is quite satisfactory. However, I have specified a bushed bearing at the lever end. Having seen the way some folk operate brake levers on my own road, I thought we might as well take precautions! Drill the hole in the bearing plate $\frac{7}{16}$ in., and fit a turned bush in it.

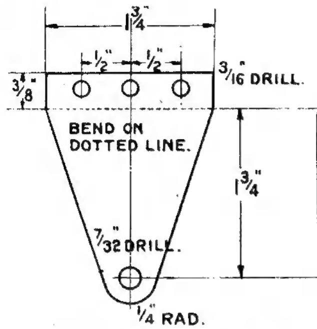


Brake shaft and lever

Just chuck a bit of ½-in. round rod in the three-jaw (bronze, gunmetal, or brass, whichever is available) face the end, centre, and drill down about $\frac{5}{16}$ in. depth with 19/64 in. or letter "N" drill. Turn down $\frac{3}{16}$ in. of the end to a tight fit in the hole in the bearing bracket, and part off at $\frac{1}{16}$ in. full from the shoulder. Reverse in chuck, put a $\frac{5}{16}$-in. parallel reamer through, and face off any burr; press into the bracket as shown.

The shaft is a piece of $\frac{5}{16}$-in. round mild-steel rod 3⅜ in. long after facing off both ends; one end is turned down to 7/32 in. diameter for $\frac{3}{16}$ in. length. The double-armed lever is filed up from ½ in. × ⅛ in. mild-steel, to the shape shown, the hole in the middle being drilled a tight fit for the shaft. The collar is a ¼-in. slice of $\frac{7}{16}$ in. or ½-in. round steel rod, with a $\frac{5}{16}$-in. hole drilled through it. Put the slice of rod in the three-jaw, centre it, and drill from the tailstock in the usual way. The easiest way to make the hand lever, is to saw and file the flat part from a piece of ½ in. × ⅛ in. mild-steel, drilling the end a tight fit for the shaft, and turning the handle (but not like you would do if the car battery konks out!) from a piece of $\frac{3}{16}$-in. round mild-steel, and brazing it on. I make all my handles that way, using white

Sifbronze to join them, and the joint is practically invisible. If anybody likes to cut the whole doings from a piece of $\frac{1}{2}$-in. round steel, well good luck to him! Turn the grip first, with the rod held in the chuck; then turn the rod taper below the grip, to the same taper as the flat one shown in the illustration, and file it flat on each side.



Intermediate shaft bearing

To assemble, drive the lever on the end of the shaft, and braze it; you should be expert at these small brazing jobs by now! Clean up, then put the bushed bracket-bearing on the shaft, with the bent-over part away from the lever. Next put on the collar; finally, put on the double-armed lever, setting it line-and-line with the hand lever, the shorter ($\frac{7}{16}$-in.) end being at the top, and the side of it $\frac{5}{16}$ in. from the shoulder. Then braze that in place, keeping the flame of the blowlamp or blowpipe away from the other end. Clean up, and you're all set to erect.

How to Erect the Shaft

Before erecting the shaft, decide on which side of the car you wish to put the brake lever. Some like it on the right, and some on the left; I prefer the latter, but you can please yourselves. In the elevation of the brake gear, I showed the lever on the left; in the plan, it is on the opposite side—that is, what will be the right side when the car is turned right way up. If that suits you, copy the arrangement exactly; if you prefer the left, simply fix the brackets at the corresponding distances on the opposite side of the centre-line, and change over the connections on the ends of the floating lever.

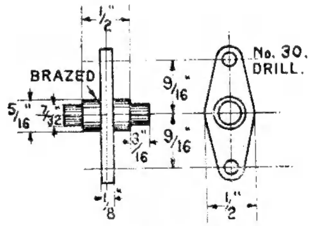
To erect, set the bushed bracket with its edge level with the edge of the seat-board, bent-over flange inwards, and the centre of the shaft approximately $\frac{13}{16}$ in. from the buffer beam; and secure it with a couple of $\frac{3}{8}$-in. round-headed wood-screws, to the underside of the seat-board. Put the other bracket on the other end, so that the brake shaft is parallel to the buffer beam, as shown in the underside view, and fix that merchant with a couple of woodscrews in a similar manner. The shaft should move quite freely. Push up the collar against the bearing bush; drill a No. 53 hole clean through collar and shaft, and drive or squeeze in, a piece of $\frac{1}{16}$-in. steel wire, filed slightly taper, to give it a start. This on one side of the bush, and the lever on the other, prevents the shaft from moving sideways.

Intermediate Shaft Assembly

The intermediate shaft is a piece of $\frac{5}{16}$-in. round mild-steel $\frac{7}{8}$ in. long, turned down for $\frac{3}{16}$ in. length at each end, to 7/32 in. diameter, leaving $\frac{1}{2}$ in. of full size between the shoulders. On this is mounted a double-armed lever, similar to the one on the brake shaft, but the arms are equal, the holes drilled at $\frac{9}{16}$ in. each side of the shaft centre. The lever is driven on to the shaft, and brazed; see illustration.

The bearing brackets are a larger edition of those carrying the brake shaft, and both are the same; all the dimensions are given in the drawing. Cut them from 3/32-in. mild-steel sheet, and bend over the flanges in the bench vice. One of them is screwed to the underside of the seatboard, level with the centre-line of same, and 6 in. behind the bogie pin; that will be slap in the middle of a two-foot car. Keep the same distance from the braked bogie on a longer car; this will avoid any interference with the rodding. Put one of the spigots of the shaft through the hole, put on the other bracket, see that the shaft lies squarely across the board, then screw down the bracket.

Connecting up is easy enough, as you already have the forks. The longer pull-rod, connecting the brake shaft with the intermediate shaft, requires a piece of $\frac{1}{8}$-in. round steel approximately $10\frac{1}{2}$ in. long with $\frac{1}{4}$ in. of $\frac{1}{8}$-in. or 5-B.A. thread on each end, to suit the forks. Screw a fork on each end, and connect to the bottom of the double-armed lever on the brake shaft, and the top one on the intermediate shaft, by $\frac{1}{8}$-in. or 5-B.A. bolts. Either regular commercial bolts may be used, or pieces of $\frac{1}{8}$-in. round silver-steel, screwed and nutted at both ends. If you happen to be a follower or relation of Inspector Meticulous, the ends could be turned down slightly, and screwed 6-B.A., so that when nuts of that size were screwed up tightly against the shoulders, the pin could still be turned by finger pressure. The nuts must not clip the forks sufficiently to squeeze them and grip the arms, otherwise the brakes will not release.



Intermediate shaft

All that now remains, is to connect the bottom end of the lever on the intermediate shaft, with one end of the floating lever, using a $\frac{1}{8}$-in. brake pull-rod approximately 4 in. long, screwed as above. Don't use a bolt in the fork connected to the floating lever; take off the latter temporarily, and pin the fork to it by a piece of $\frac{1}{8}$-in. round silver-steel through the lot, slightly riveting over the pin on the outside of the fork.

(*Continued on page* 42)

A MODEL PRESSURE GAUGE

by K. Evans

PRESSURE gauges for models are usually made on the principle discovered and patented just over a century ago by Bourdon, a Frenchman. He had observed that a hose pipe which lay curved on the floor straightened out as soon as the water was turned on and realised that a curved metal tube would behave in the same way, but would return to its original shape when the pressure was shut off. The model gauge to be described (Fig. 1) has the Bourdon tube soldered into a screwed block which forms the pressure connection. The tube is oval in section and the free end, which moves upwards when pressure is admitted, is connected by a rod to the spindle which carries the pointer. The spindle carries a bent wire crank on to which the connecting-rod is threaded, and also the pointer which moves across the dial and so registers the pressure. The mechanism is enclosed in a brass case with a circular window.

The Bourdon tube is the heart of the gauge and will probably prove the most difficult part to make. For a working pressure of between 40 and 60 p.s.i. a gauge graduated to 120 p.s.i. will be used, for which pressure the Bourdon tube should be made from hard rolled brass or bronze sheet 0.006 in. thick. To make this into an oval tube an aluminium mandrel is made (Fig. 2) to the sizes shown and the sheet bent round it so that the seam comes along the middle of one of the long sides. This seam must now be soldered to make a pressure-tight joint without thickening the material. A silver-solder should be used, preferably one of the low melting point types such as Easyflo made by Messrs. Johnson, Matthey and Co. Ltd., Hatton Garden, London, and it must be applied very sparingly and any surplus cleaned off so that when finished the joint is almost undetectable. Silver-solder cannot, of course, be applied with an iron, so a blow pipe with a fine flame will be needed for this operation. After this has been done successfully—and several attempts will probably have to be made before a good tube is made—the tube should have a number of strands of soft string pulled through it, using a needle if necessary and then bent round a bar into an arc of a circle. The string is then removed. If preferred, the tube can be filled with fine table salt and the ends sealed over by folding the metal before bending. If this is done, great care must be taken to remove all traces of salt afterwards.

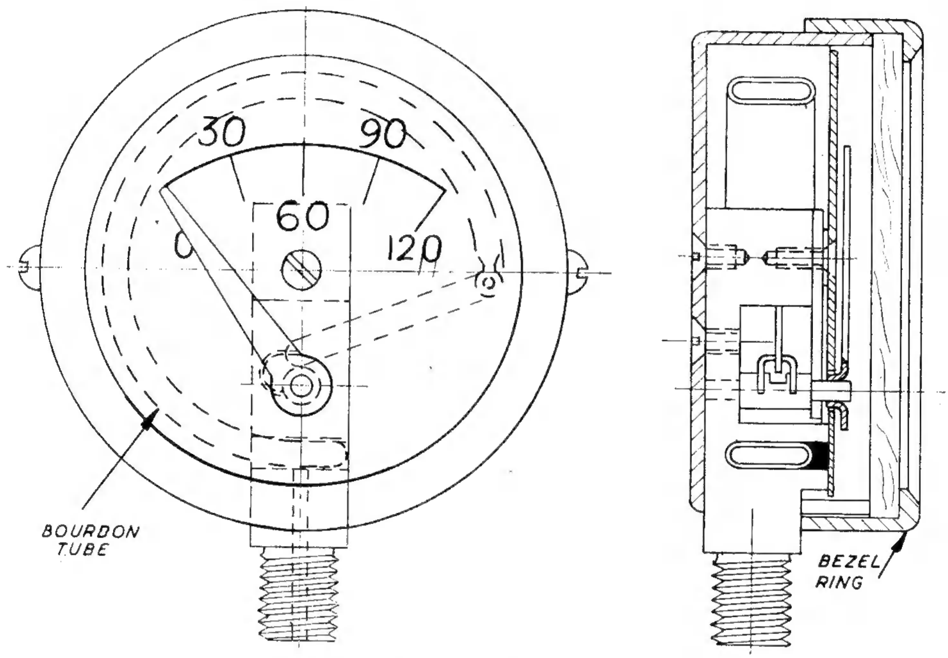


Fig. 1. Elevation and section of the model pressure gauge

The tube block is made from brass bar, the

thread being turned and then the shape filed to that shown. The Bourdon tube is soft-soldered into the slot, using an acid-free flux to make sure that there is no likelihood of internal corrosion developing in the tube. The hole in the block should then be drilled through into the tube and a test made to make sure that there is a clear passage from the inlet to the free end of the tube, which should have been left open. The free end of the tube can then be pinched up can be done with a draughtman's pen, but the figures will have to be inked in by hand so that some practice will probably be needed if the dial is to have a professional appearance.

The case and bezel ring are turned from brass bar, as it is unlikely that the amateur will be able to make these from sheet metal, and are held together by two small screws through opposite sides. The window is a circle of $\frac{1}{16}$-in. Perspex.

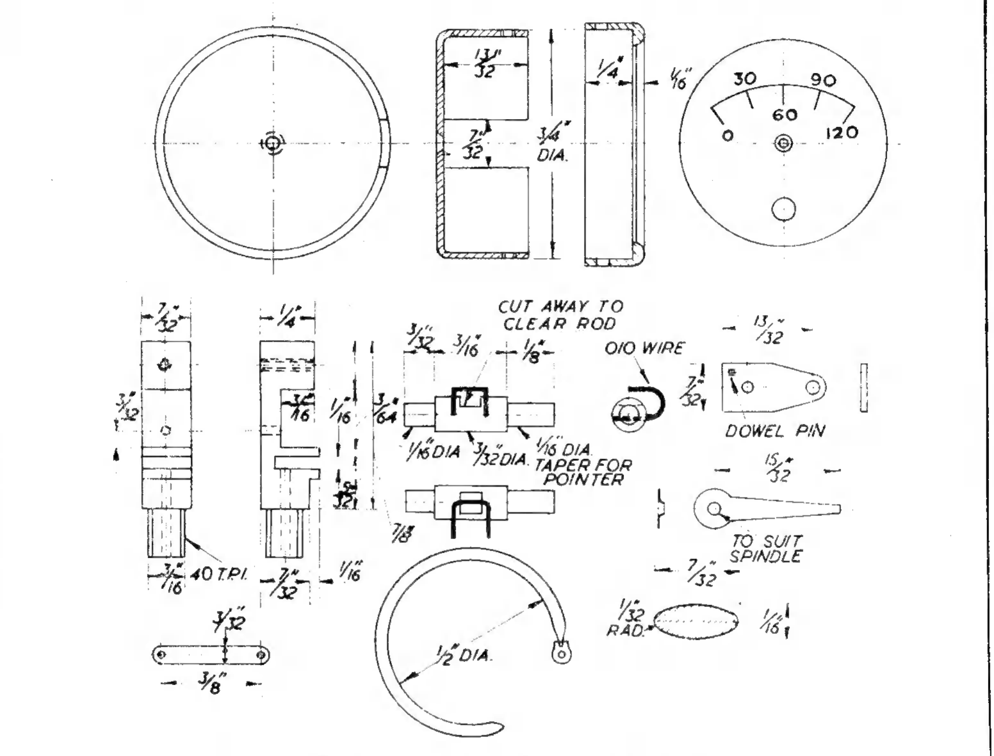


Fig. 2. The component parts of the model pressure gauge

and a small sheet-metal eye for the connecting-rod fitted to it and secured by soft-soldering ; at the same time, sealing the end of the tube. The pointer spindle is also made from brass and is fitted with a wire crank in two holes, drilled as shown. Before securing the crank, the connecting-rod is threaded on it. The front end of the spindle is turned slightly taper to take the pointer which is made from sheet brass about 0.010 in. thick and has the hole punched through to form a sleeve in a similar way to the hands on some clocks and watches. The dial can be made from the same material as the pointer and the front is painted white with a good-quality matt white cellulose paint. Great care should be taken to apply the paint evenly, and there is no need for a thick coat. The markings are not put on until the gauge is calibrated and these should then be done in indian ink. The circle and lines

However well the gauge may have been made it will be of little use unless it is calibrated correctly. If a reliable commercial gauge can be borrowed this can be used for the purpose, but if this is not available it is a simple matter to make a primary gauge which will give a pressure measurement based on a known weight and area. The principle is similar to that of a weight-loaded safety-valve, as will be seen from Fig. 3. The main block is made from a length of brass bar which is reamed out to take a plunger made from $\frac{5}{16}$ in. diameter silver-steel. The plunger is fitted with a brass head and the weight of the two adjusted on a scale to a convenient figure, say $\frac{1}{2}$ lb. The side branch to take the gauge is soldered in and tapped at the upper end, whilst the lower end is screwed to take a cap, or may be left solid if a sufficiently accurate hole can be reamed without having to pass the reamer right

through. To calibrate the gauge, the tube block assembly, without dial or case, is screwed into the side branch, the block being held vertically in a vice, and with the plunger removed, a medium bodied oil is poured into the $\frac{5}{16}$-in. hole until it is about one half full. The plunger is

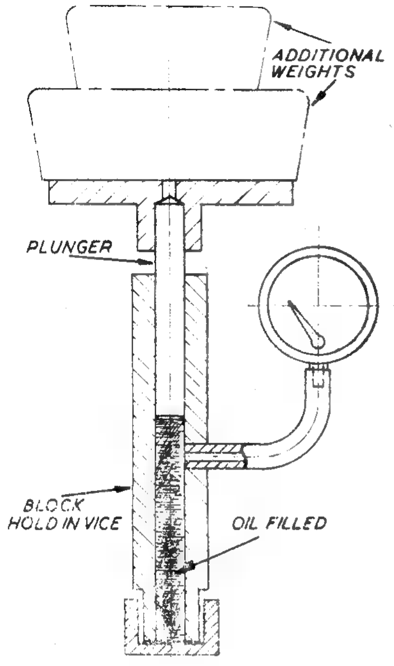


Fig. 3. Primary gauge for calibrating model

then replaced carefully, time being allowed for the trapped air to escape; if everything is all right the gauge will respond to the pressure generated as the plunger is pushed home. The next step is to make sure that the pointer makes the correct amount of movement—between 70 deg. and 80 deg. when the full pressure of 120 p.s.i. is applied. To apply this pressure a weight equal to the pressure multiplied by the piston area is placed on the plunger head. The pressure is 120 p.s.i. and the area of a $\frac{5}{16}$ in. diameter circle is 0.0767 sq. in. giving a weight of 120 $\times$ 0.0767 lb. or 9.204 lb. including the weight of plunger and head, or if these weigh $\frac{1}{2}$ lb., and additional weight of 8.704 lb. The weights should be added slowly until the full amount has been applied and then the piston should be rotated to reduce the effects of friction. If the pointer movement is not correct, a first adjustment should be made with the wire crank, bending it away from the centre if the movement is too much and towards the centre if too little. The most probable trouble will be that there is insufficient movement even when the crank is moved inwards as far as it will go, and to overcome this the Bourdon tube must be flattened carefully for as much of its length as possible—the flatter the tube the greater its movement for a given pressure.

When the pointer travel has been adjusted satisfactorily, the dial can be screwed on, the pointer replaced and the actual work of calibration begun. The full pressure is applied several times to make sure that the pointer moves over a scale which is symmetrical about the centre-line and pencil dots are placed at zero and full pressure. Although an approximately correct scale could be obtained by dividing the arc between zero and 120 p.s.i. into four equal parts it is advisable to mark the points corresponding to 30, 60, and 90 p.s.i. under pressure and to do this it will be necessary to apply successively weights (including the plunger and head) of 2 lb. 5 oz., 4 lb. 10 oz. and 6 lb. 15 oz. and mark the dial accordingly. After spotting, the dial is removed and marked in ink as explained previously. It now only remains to fit the block, tube and dial in the case and screw them together. Most people prefer to leave the case and bezel ring their natural colour, and they should then be polished in the lathe with fine emery and clear lacquered. If preferred, these parts can be plated but it is advisable not to plate the Bourdon tube, as it is too fragile to be put into a plating vat.

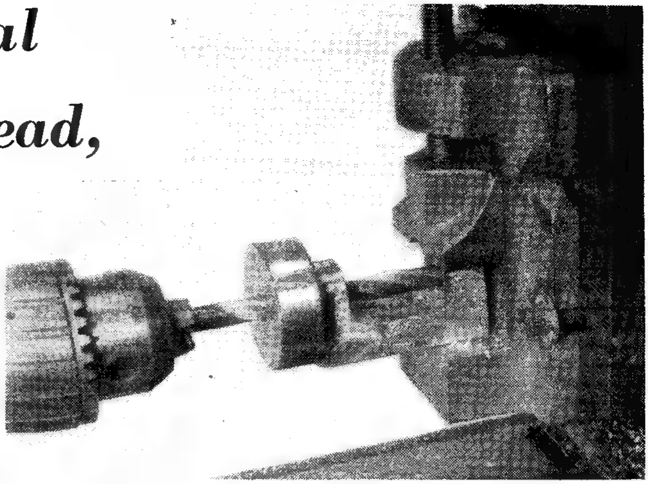
"L.B.S.C.'s" Beginners' Corner

(*Continued from page* 39)

Replace floating lever, and connect up as shown in the underside view in the last instalment. To release the brakes when the driver lets go of the lever, file up a little eye from a bit of 3/32 in. $\times$ $\frac{3}{16}$ in. steel, screw the shank, and screw it into the back of the buffer beam. A tension spring wound up from 22-gauge tinned steel wire, is connected to this, and to the upper end of the double-armed lever, as shown in the illustrations. The pull-rods are adjusted so that the brake blocks are quite clear of the wheels, say $\frac{1}{16}$ in. away from the treads, when the brake is off; that is a little trial-and-error job which you can do with the car upside down on the bench, with a block of wood, or something similar, under each end, so that the hand lever will clear. Try the car on the road, by sitting on it and "kicking off" with your foot on the ground; it should start easily, coast freely, and a very light pull on the brake lever should bring it to rest quickly, but with a smooth action. Next stage, footboards, and trip recorder. Don't forget that full-size blueprints of this car will be obtainable from our offices; many inexperienced workers find it easier to follow the full-size drawings, than "scale up" small illustrations.

*A Universal Dividing Head, PLUS

by A. R. Turpin



Photograph No. 24. Drilling the hole through the spindle bearing bracket

THE bearing and fixing hole faces should now be spot faced, and this can best be carried out by making ■ special cutter with ■ $\frac{5}{16}$-in. centre hole ; this may be secured to ■ $\frac{5}{16}$-in. silver-steel spindle by ■ set-screw.

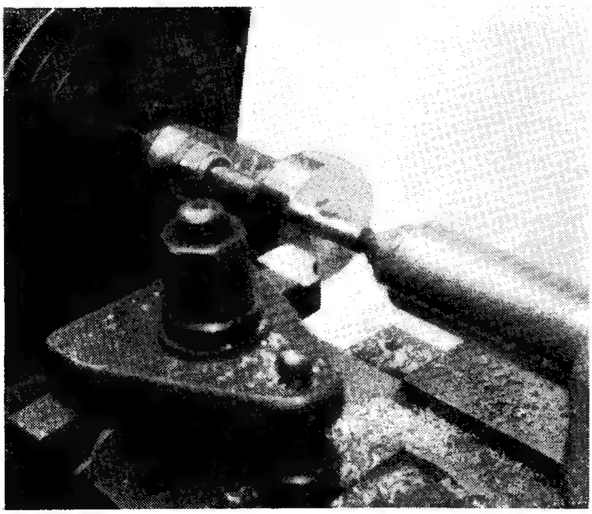
Fix the spindle in the four-jaw or collet chuck, thread it through the first bearing hole, then the cutter, and finally second bearing.

Tighten the set-screw, bring up the tailstock so that it can be used to feed the bearing against the cutter, and spot face the bearing. Reverse the bearing bracket on the spindle and repeat on the other face, and finally on the outside face, and also that of the fixing screw hole.

A length of $\frac{5}{16}$ in. diameter B.M.S. is now screwed $\frac{5}{16}$ in. B.S.F. for a length of $1\frac{1}{2}$ in. ; this rod is then pushed through the boss end of the bearing, and ■ nut threaded on and screwed back to the end of the threaded portion ; the bearing is then clamped to the spindle by ■ second nut, and the protruding end of the threaded portion gripped in the four-jaw and adjusted so that the spindle runs truly. The far end is now centre drilled, and the back centre brought up so that the spigot on the circular boss can be turned concentrically with the spindle and also the division plate seat machined. This set-up is shown in photograph No. 25.

Leave the drilling and tapping of the three 6 B.A. screw holes for the time being.

*Continued from page 852, Vol 105, "M.E." December 27, 1951



Photograph No. 25. Turning the division plate seating on the spindle bearing bracket

The Spindle

This item is unnumbered, and is shown in Fig. 21. A length of $\frac{1}{2}$ in. diameter mild-steel is mounted between centres and turned down to the dimensions shown, the portion threaded 32 t.p.i. should preferably have the thread machine cut, because this carries the bearing adjusting nut, and the nut should rotate squarely on the spindle, but the $\frac{5}{16}$-in. B.S.F. may be cut with ■ die held in the tailstock die holder.

The spindle and worm should now be mounted in the bearing bracket and the position found for the 5/0 taper pin hole, which should then be drilled through them both whilst mounted together with No. 50 size drill ; this is followed by a taper reamer. These small fluted reamers are expensive, but tapered "D"-type reamers are quite simple to make. The worm having been fitted to the spindle, the position of the $\frac{5}{16}$-in. tapped hole in the mandrel bearing casting for the fixing screw can now be found. The worm should be mated with the wheel without allowing any clearance ; it should also be centrally disposed to the rim of the wheel, and this may mean placing

a shim washer behind the bearing bracket or reducing the height of the land on the side of the mandrel bearing casting.

Once the correct position has been found, a $\frac{5}{16}$-in. diameter centre punch can be turned up and pushed through the fixing hole of the spindle bracket, and given a tap. The fixing hole in the bracket should be slightly elongated to allow adjustment for wear. Whilst the position of the tapped hole is being found, it is important that the pin end of the worm is kept pressed against the left-hand bearing face of the spindle bearing.

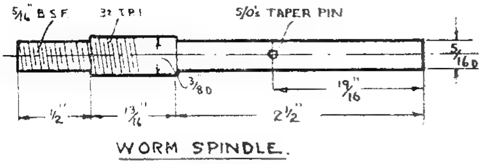


Fig. 21

The Division Plate (15)

This is shown in Fig. 22. It consists of a 6-in. brass blank $\frac{1}{8}$ in. thick that has been turned down to $5\frac{1}{2}$ in. diameter. To do this it should be mounted on the morse taper arbor used when turning the mandrel. This arbor should have a $\frac{5}{16}$-in. tapping hole drilled in it to a depth of 1 in., this hole is then carefully opened out with a small boring tool to exactly $\frac{3}{8}$ in. to a depth of $\frac{1}{2}$ in. the hole is then tapped for the remainder of its length $\frac{5}{16}$ in. B.S.F. and a special stud turned and screwed to fit it, the plain portion acting as a register so that various size stubs may be screwed in if required.

In the case in question, a $\frac{3}{8}$ in. diameter stub is used with a screwed end. The centre of the blank is found, and drilled $\frac{3}{8}$-in. clear, placed on the arbor, and mounted in the lathe mandrel, and the diameter turned down to $5\frac{1}{2}$ in. diameter. The blank is now gripped in the three-jaw, and the centre hole enlarged to 1 in. diameter to fit nicely on the spigot on the spindle bearing casting. Leave the drilling and tapping of the three 6 B.A. holes for the time being, and we can start on the actual division of the plate.

Dividing the Plate

If you can beg or borrow a copy plate, things will be much simpler, because this plate can be fixed behind the new one, and a detent arranged to engage the holes whilst the other is drilled with a drilling spindle mounted on the cross-slide. On no account clamp them together and use one as a drilling jig. If you cannot obtain one, then the only thing is to start from scratch and use the "perforated strip" method to divide it. Roughly, this method is as follows: A strip of metal is jig drilled with equidistant holes, the strip is then cut to such a length so that it contains one more hole than the number of divisions required. A wooden disc is mounted on the lathe faceplate, and the diameter reduced until the end holes exactly overlap when the strip is wound round the periphery of the disc; a pin is then driven through the overlapping holes securing the strip to the disc, and at the same time dividing the edge of it into the required number of the divisions. A detent is now arranged to engage the holes in the strip, and if the division plate is mounted in front of the disc it may be drilled with a spindle drill mounted on the cross-slide. There are, however, a number of snags that have to be overcome if really accurate results are required, and the method actually used will be described in detail, and is as follows:

The first thing to decide is the spacing of the holes in the strip and this should be such that the diameter of the disc should be as large as possible compared with the diameter of the circle of holes on the division plate proper. The largest number of divisions being 49, we can use the nice round figure of $\frac{1}{2}$ in. which will give a disc diameter of just over $7\frac{1}{2}$ in.

A number of strips could be prepared, one for each circle of holes, but considerable time can be saved by using the same strip, and cutting off those holes not required; but when the number is reduced below 25, the size of the disc begins to get extremely small, this also can be overcome by using every other hole for any divisions smaller than 24. It is, however, advisable to mark alternative holes with a spot of paint to avoid confusion when actually making the divisions.

I found that using ordinary mild-steel for the

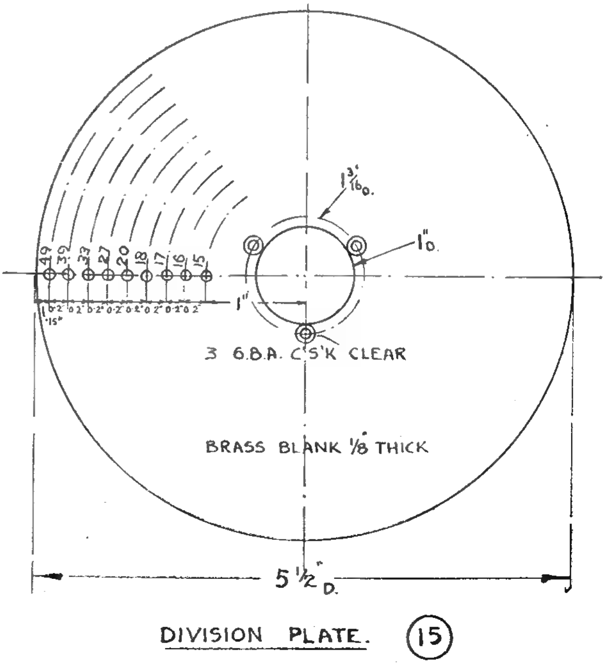


Fig. 22

strip was a failure ; it would no doubt be quite successful if the strip had to be used only once, but continual removal, and replacement on to the disc caused it to kink, and it was extremely difficult to draw it closely round the edge of the disc. The best material was found to be a length of gramophone motor spring ; the piece used was $\frac{3}{4}$ in. wide and 0.01 in. thick. It was used in its tempered condition, and the holes were punched, which was found to give a very clean hole ; it was considerably quicker than drilling.

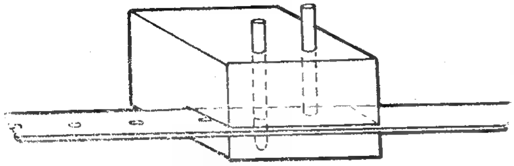


Fig. 23. Jig for punching the perforated strip

The first operation is to mount a disc of wood on the lathe faceplate having roughly sawn it to shape ; the thickness being about $\frac{7}{8}$ in. This is now turned down to a size slightly larger than the calculated size required, say 8 in. A jig is now made as shown in Fig. 23. This consists of a piece of steel bar, $1\frac{1}{2}$ in. wide, 2 in. long, and 1 in. thick. One end is faced, and ■ line scribed along the top parallel to this face, and half the width of the strip from it. Two $\frac{3}{16}$-in. holes, $\frac{1}{2}$ in. apart, are now drilled and reamered right through on this line and ■ saw cut made, preferably with a 1/32 in. thick slitting saw. This should be $\frac{3}{8}$ in. from the bottom, and to a depth equal to the width of the strip.

Now cut two lengths of $\frac{3}{16}$ in. silver-steel rod, $1\frac{1}{2}$ in. long ; one of these—we will call it the locating pin—has a blunt point turned on it, whilst the other, the punch, has the tip hardened and tempered to a dark straw, and then the end is ground and honed dead square ; any burr being removed with an oilstone slip whilst the pin is revolved in the lathe, but be careful not to reduce its diameter.

The jig is now gripped in the vice, and the strip of gramophone spring pushed into the sawn slot, care being taken that it bears squarely against the back of the saw cut. Insert the punch in the hole, and give it ■ smart tap with ■ hammer, and you should punch a clean hole right through it ; no great force is necessary to do this unless your punch is not properly sharpened. Now slide the strip along until you can insert the locating pin through the hole just punched making certain that the full diameter of the pin has entered the hole, and not only the tapered portion. Repeat this process until you have 50 holes, and then trim the ends down to within $\frac{1}{4}$ in. of the holes. The strip may now be tried round the periphery of the disc, the distance by which they fail to overlap noted, and the diameter of the disc reduced by one-third of this amount, and the strip fitted again. Repeat the procedure until the end holes exactly overlap, or at least do so within a few thous. As a matter of fact, it is suprising how much slack there can be without the accuracy being affected, this is no doubt due to the spring in the strip distributing the error

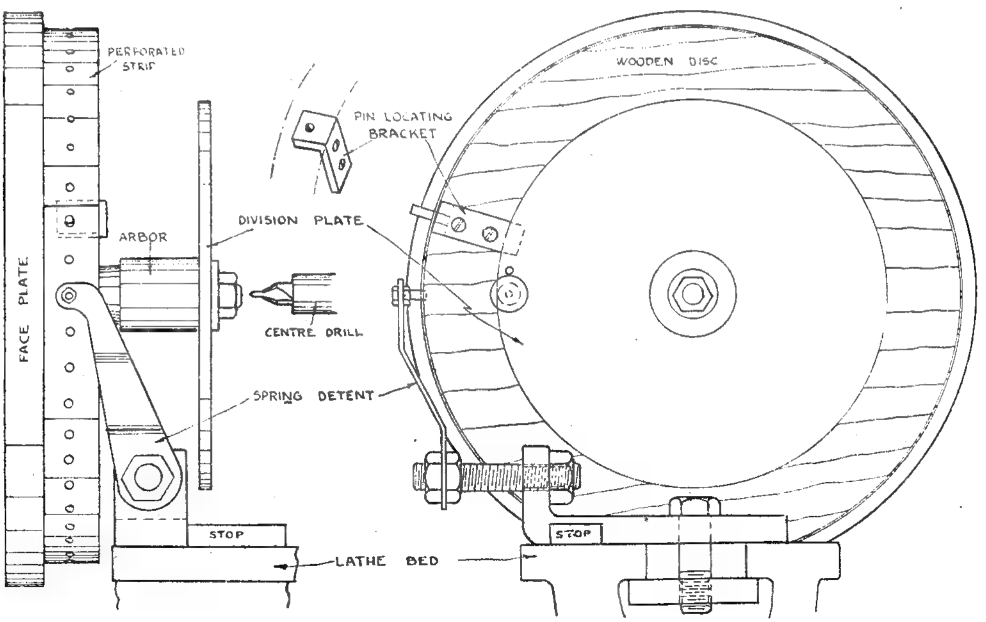
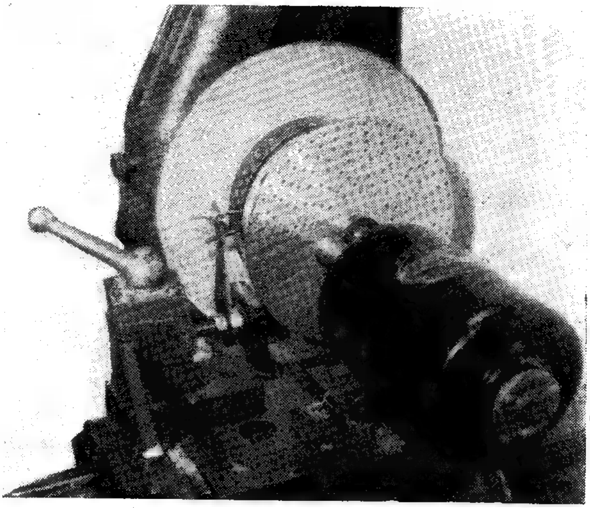


Fig. 24. Set-up for dividing the division plate

equally round the circumference.

It would soon become apparent, that if we now drive a peg through the overlapping holes to secure the strip, we shall eventually want to insert the detent pin in its place, but if we remove the peg, the registration will be lost. This snag is overcome by bending an L-shaped plate from $\frac{1}{2}$ in. × $\frac{1}{8}$ in. strip. A $\frac{3}{16}$-in. hole is drilled and reamered in the foot of the "L" $\frac{1}{2}$-in. in, and two holes to take No. 4 countersunk wood screws drilled in the upright. A recess is now cut with a chisel in the circumference of the disc to take the foot of the plate, and the locating peg pushed through the overlapping holes into this. Now when the peg is removed, and ends of the strip released, there is still this hole left for registering the detent pin. This is shown in the detail in Fig. 24. The locating peg which can be a short length of $\frac{3}{16}$-in. silver-steel should be hardened and tempered to a blue, otherwise the spring steel will cut into it, making it difficult to withdraw.



Photograph No. 26. Set-up for dividing the plate, showing the final hole being drilled

The next item is the detent bracket. This is made from a piece of 1 in. × $\frac{3}{8}$ in. steel bar, with one end bent up as shown in Fig. 24; in this end is drilled and tapped a $\frac{3}{8}$-in. B.S.F. hole; a length of studding is screwed into this tapped hole, and secured with a lock-nut at the back. This bracket is clamped to the lathe bed by means of another plate below the "ways"; the plate of your fixed steady will do if you have one.

The spring steel support arm is cut from 16-s.w.g. material, and clamped to the studding as shown. The hole for the detent pin is offset so that the support arm clears the locating peg when registering the last two holes. The pin itself is a hardened length of $\frac{3}{16}$-in. silver-steel screwed one end 2 B.A. and held in position by two nuts. It will be seen from the drawing that as the diameter of the disc is reduced, the position of the detent pin can be adjusted accordingly by moving the spring arm along the studding. The adjustment should be such that the pin can be pulled clear of the hole in the strip, and snaps back when released.

It should be noted that the disc should always be turned in a clockwise direction, otherwise there is a danger that the faceplate will be screwed off the mandrel.

A radial line is lightly scribed on the division plate which is then mounted on the morse taper arbor, a suitable bush being turned to fit the centre hole, the plate being held by a large-diameter washer and a nut screwed to the stud previously used; the arbor is then inserted in the lathe mandrel, but not pushed fully home.

A drilling spindle that can be mounted on the cross-slide is required next, and this should be fitted with a B.S.3 centre drill. Not having a drilling spindle myself, I used a fractional h.p. motor, and turned up a simple quill that fitted directly on to the motor shaft, and the centre drill pushed in the other end, securing the drill and the shaft to the quill with 4 B.A. Allen screws. The motor was then mounted on the cross-slide, packing it up so that the drill was at centre height.

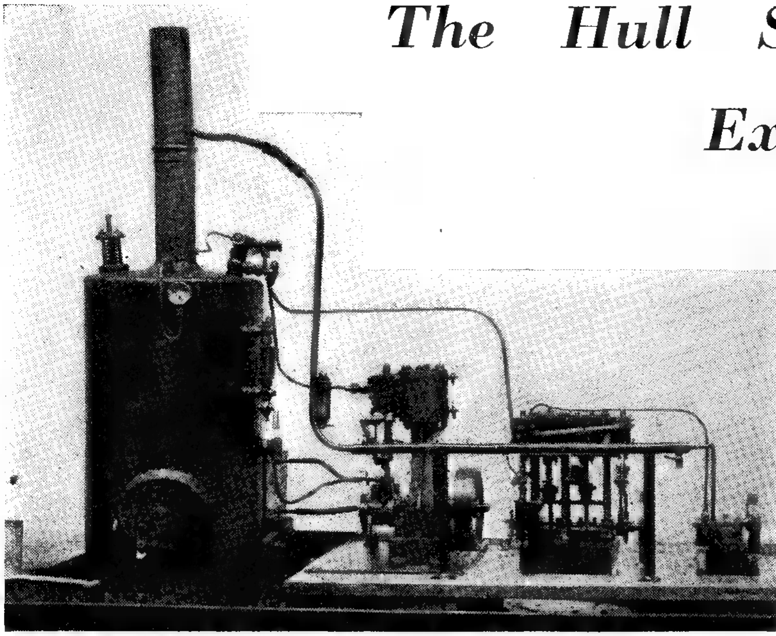
The drill is now traversed in until the point of the drill is level with the periphery of the division plate, the detent pin is entered into the hole below the locating peg, the scribed line on the plate brought opposite the point of the drill, and the arbor tapped home. Give the cross-slide feed-screw one and a half turns to bring the point of the drill 0.15 in. in from the edge of the plate, and take a note of the index reading. The first hole can now be drilled by racking the cross-slide forward, and feeding the drill to a depth to give some countersink, and the point just emerges from the other side. The depth stop consists of a short length of steel bar cut so that it just fits between the front of the carriage and the detent bracket; this stop will ensure that all holes are drilled to the same depth, not that accuracy will suffer if they are not, but the appearance of the job will, this is shown in Fig. 24.

There is one other point that it would be as well to mention here. At the completion of each circle of holes the diameter of the wooden disc has to be turned down, and to save the trouble of dismounting the motor and replacing with the toolpost, the back toolpost is used mounted on the front of the cross-slide and fitted with a long turning tool; by releasing the clamping-screw of the toolpost, the tool may be rotated out of the way and brought back as required. The whole set-up is shown in photograph No. 26.

The cross-slide is now racked back, the detent retracted, and the disc rotated in a clockwise direction so that the next hole can be located, and drilled. Repeat until the hole with the location peg is reached, and then remove the pin and locate in the hole in the L-shaped plate. This completes the 49-hole circle.

(*To be continued*)

The Hull S.M.E.E. Exhibition



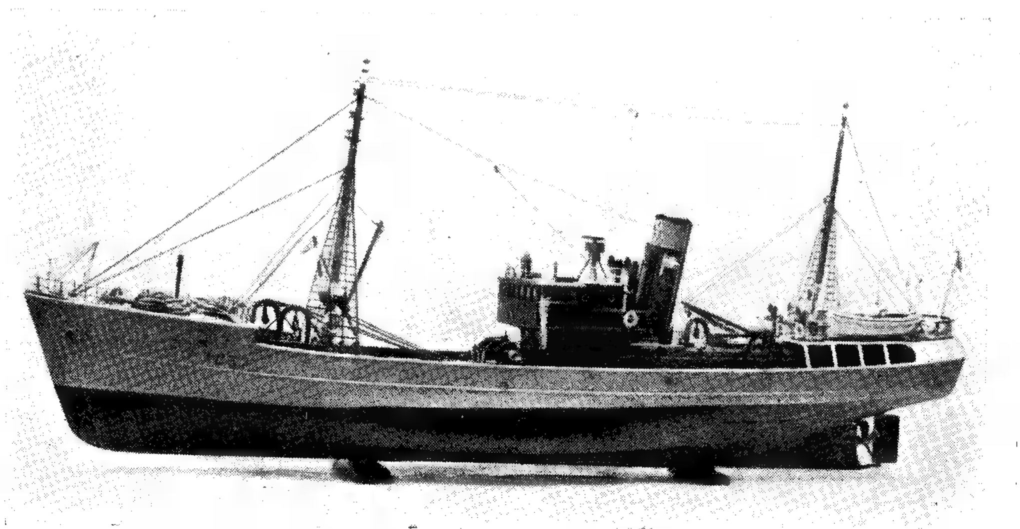
This model steam plant was run under steam throughout the exhibition

A VERY successful exhibition by the Hull and District Society of Model and Experimental Engineers was recently held in the East Hull Barracks, Holderness Road, Hull.

The entries were very varied and covered a full range of models : ships, locomotives, traction engines, stationary engines, etc.

A feature of the exhibition was the locomotive loaned by Mr. Miller of Brighouse, *Duchess of Brighouse* with motion being turned by compressed air. The society's new portable track, as well as providing a useful contribution to local charity by giving rides to children, was shown to great advantage by a section of it being used as a grand stand on which to display locomototives, and some 23 exhibits of this class were on view.

The ship section was of a very excellent

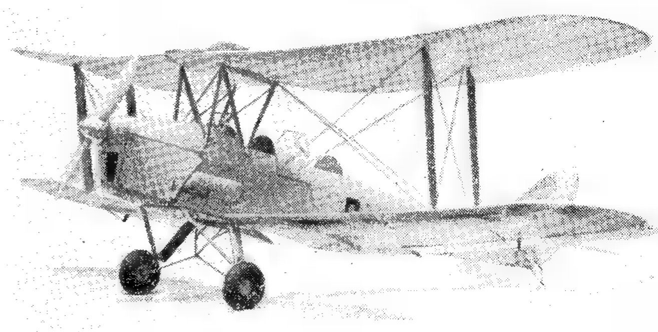


A model trawler exhibited by Mr. Gregory

standard and the trawler by Mr. Gregory was admired. A very fine model of a local type of ship, the Humber barge was displayed in part-finished state, showing excellent construction details by Mr. Harrison, of Beverley.

Our oldest member, Mr. Morley, aged 84 years, showed an excellent agricultural portable engine.

A splendid model of a house made from matches by Mr. Townsend aroused interest, as this model was made whilst he was ■ hospital patient, and ■ feature of it was that it was sectionalised in stories.

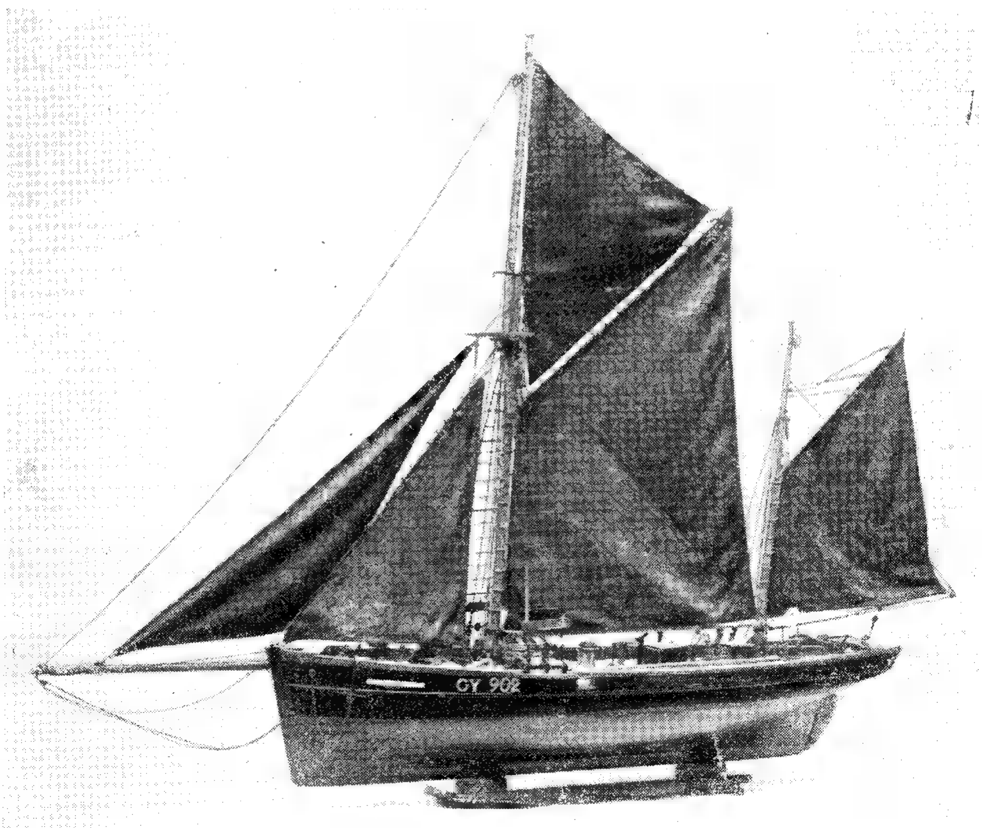


One of the aircraft models on show at the Hull exhibition

A steam plant operating ■ marine compound, ■ vertical engine, and a horizontal engine all coupled on one base was seen to attract attention.

A harmonagraph by Mr. G. Wilson and Mr. Sharpe produced during the week a great number of designs which now must be in many households in Hull and district. Finally, Mr Coulson's puppets held both young and old alike by their antics.

All told, a highly successful event.



A fine model of an old fishing smack. Many of these vessels sailed from Hull in the old days

*The Allchin "M.E." Traction Engine

to $1\frac{1}{2}$-in. Scale

by W. J. Hughes

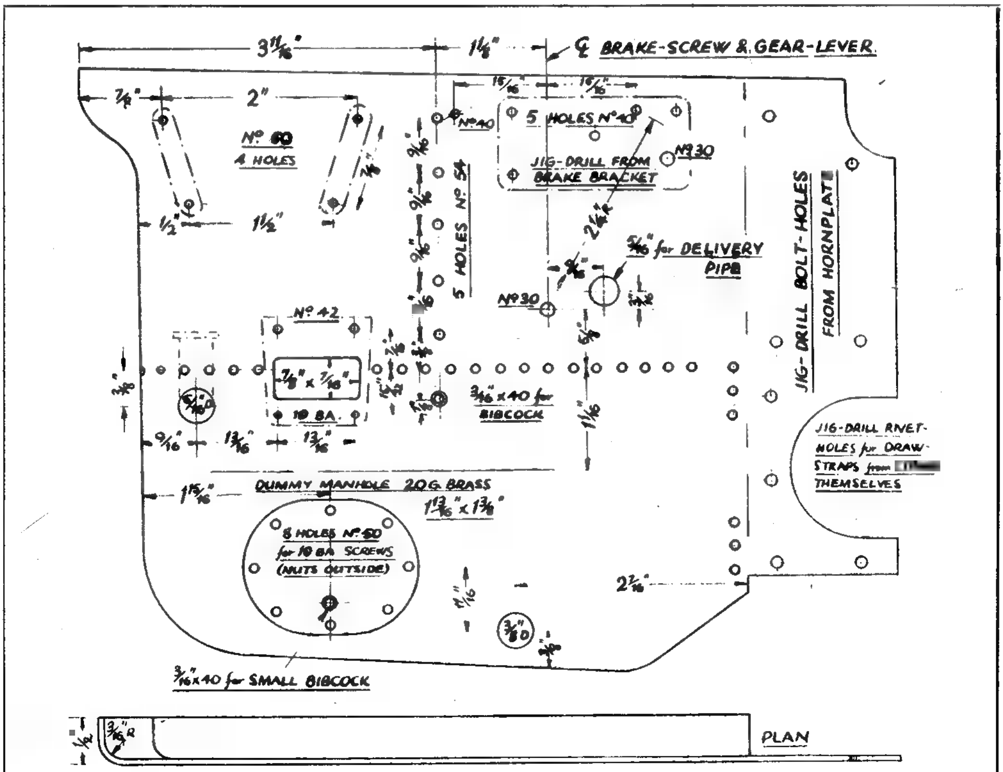
As most readers will know, bending and/or hammering metal-work, hardens it, and annealing or softening is necessary from time to time to release the tension, so to speak. If you have started off with "hard-rolled" or "half-hard" brass, you won't get far with the flanging—a few degrees only—before annealing is necessary. Even if you've used the "soft" variety—that is, ready-annealed—re-softening will be needed before long. The hardness can be detected by a difference in the "feel" of the blow—the metal resists more and the sound is harder, and if you persist, the edge of the metal will merely crinkle instead of lying further over. When doing my flanges, I found it necessary to anneal each five or six times altogether. Perhaps it could have been done in less, but I think it's less trouble to anneal than to keep on banging away at metal that doesn't want to go!

*Continued from page 806, Vol. 105, "M.E.," December 20, 1951.

"Cherry-red"

Brass is annealed by heating red-hot—"cherry-red" is what some of the text-books say. It should not be handled while at red heat, being "hot-short," and should be allowed to cool to black heat before being quenched either in "pickle" or in cold water—preferably the former, to remove the oxide. If you haven't a pickle-bath, it is desirable to clean up the brass with emery or silver-sand before starting to flange again, partly to make it pleasanter to handle, and partly to prevent the oxide being worked into the surface, which would *not* ease the subsequent soldering operations. *Warning*—don't get the brass too hot or you'll burn it.

The heating and cooling may have warped the

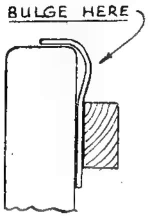


Elevation and plan of right-hand tender-side, showing setting out of holes

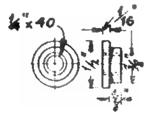
tender-side somewhat, but a few taps with the mallet on a flat surface, will do the needful, and the flanging can then continue as before. All the time, great care should be taken not to hit the brass with the *corner* of a mallet, which may easily bruise the surface and cause a blemish difficult to remove.

Points to Watch

The places to watch particularly are on the curves, both inside and outside, and I would stress again that the "laying-down" of the flange should be gradual and equal all the way round the two edges. As mentioned, the round-nosed mallet is needed on the inside curve near the top at the back, and here the metal has to "stretch" slightly to fit down to the former. But the danger is the possibility of *over*-stretching it by hitting too hard or too often. To avoid this, when the flange is nearly laid down all round, with perhaps $\frac{1}{16}$ in. still to go, anneal it well, and finish the laying-down except at this part, which is done last.



A possible danger to be avoided when flanging



Nipple for water cock

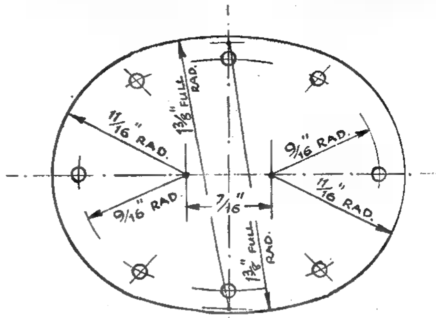
Now on the *outside* curves at top and bottom of the back, the outer edge of the metal has to be *compressed* in order to lay it right down, and it is permissible to use a little more force—but not too much—here.

In all the flanging, once it has been well started, you should not use too much of the sideways motion of the mallet, but rather more direct blows, especially on the outside curves, using the "flattened taper" mallet. From time to time, and especially after annealing, use the mallet on the *radius* of the flange—but not too hard—to prevent any bulging of the work on the outer edge.

A similar "bulging-out" is possible on the flat side, as sketched; it can be prevented by keeping the clamping strip as close to the edge as practicable, and if it should occur despite that precaution, the remedy is obvious—tap it flat again.

Right-hand—Left-hand

When the flanging of one of the sides is finished, you will naturally do the other one—but remember, one is right-handed *and one left-handed.* I emphasise this because even experienced engineers have been known to make "two alike" when they really needed a pair! Take the same precautions as with the other, and you should soon have a nice pair of tender-sides.

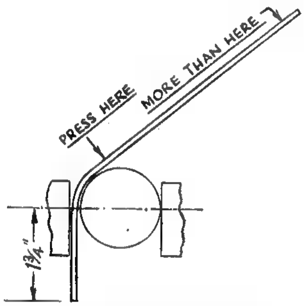


Setting out the dummy manhole cover

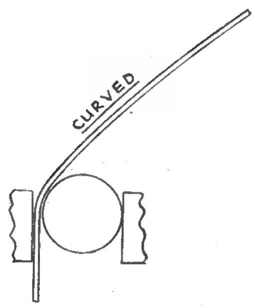
There will be a certain amount of waste to remove from the edges of the flanges; lay the sides on a flat surface, flange uppermost, and with a scribing block set to $\frac{1}{2}$ in., mark a line all round the flange on the outside. Mark the second side, then reset the block to $\frac{1}{4}$ in. and scribe a second line inside the first, to show how far the back and bottom of the tender overlap the flanges, when riveted in place.

The amount of waste will vary according to how much you have "clouted" the material—brass can stretch quite a way—but it is removed by filing. If there is an excess, saw some off first, with the plate clamped to the bench or in the vice, and the saw blade turned sideways in the frame.

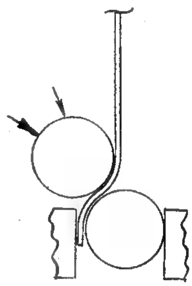
With the waste removed, the driver's entrance



Making the first bend, round bar gripped in vice. Vice-clamps not shown, but essential



A possible danger, caused by pressure at the top of the sheet



Making the second bend, using a piece of round bar on the first curve

can be set out and cut, on the left-hand side, but remember, it is *not* square with the top edge. Don't file right back to the line yet—this is best done after soldering on the half-round beading, at a later stage.

Drilling the Holes

While dealing with the sides, we may as well mark out and drill the holes, of which there are quite a few! It should be remembered when setting out, of course, that the front edge of the tender side is the reference edge; in other words, all the lines are square with or parallel to it.

First of all, set out and drill the central line of rivet holes in the sides—No. 54 at $\frac{1}{4}$ in. centres—but drill only *one* of those where the footstep is fixed at one end. Mark and drill the rivet holes for the tank front, and the vertical line of holes for the coal-plate. Those on the left side are slightly countersunk because here the rivets have to be flush—the half-round beading partly covers them—but on the right the rivets are round-headed, so the holes aren't countersunk.

On the left side set out the centre-line for the lower footstep, but drill only the central hole.

A centre-line for the draw-straps is set out on both sides, but no holes are drilled.

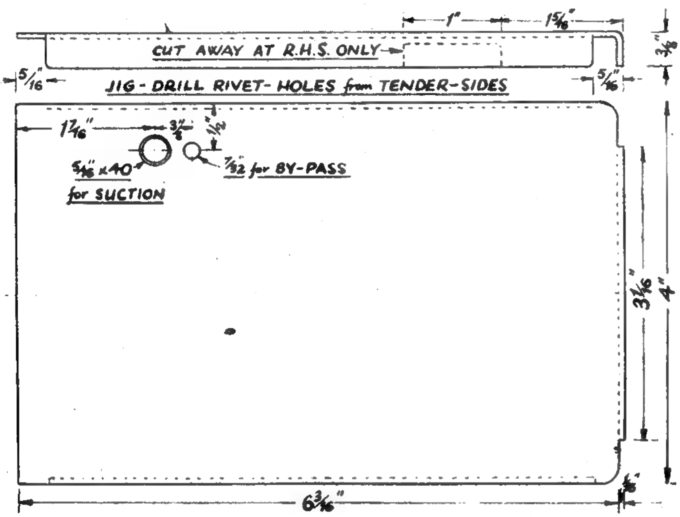
On the right-hand plate cut the opening for the water-pocket—I like to use a tension-file for such jobs—and drill the two upper holes only for this fitting. Do not drill the fixing holes for the hose-brackets and the brake bracket, which can be done later, but those for the water-lifter stand-pipe and the watercock nipple should be drilled at this stage. In fact, this nipple should be silver-soldered in now, so we'd better get it made, hadn't we?

Chuck a stub of $\frac{1}{2}$ in. dia. bronze rod in the three-jaw, face the end, centre it, and drill 7/32 in. Tap $\frac{1}{4}$ in. $\times$ 40, and reduce the diameter to $\frac{3}{8}$ in. for a distance of $\frac{1}{8}$ in. Take a skim off the full diameter, and part off at $\frac{1}{16}$ in. from the shoulder.

The nipple for the watercock is silver-soldered into the $\frac{3}{8}$ in. dia. hole near the bottom flange on the right-hand side. In this position, the injector not only has no lifting to do, but is also protected by the hind wheel from knocks or other damage.

The Manhole

Our model manhole is a dummy, but it helps to give realism and so is a necessary fitting. It is simply an oval $1\frac{13}{16}$ in. long $\times$ $1\frac{3}{8}$ in. wide cut from 20-gauge brass, with eight No. 50 holes drilled for the holding screws, which are 10 B.A. The diagram shows a quick and easy method of setting out the oval with a pair of dividers, and nobody will notice that it isn't a true ellipse. Possibly the big 'un was set out in exactly the same way!



The tank-top or footplate. The rear corners are filed to fit the tender-flanges

To fix the manhole, first set out the vertical and horizontal centre-lines on the tender side, and place the oval in position with its centre-lines coinciding with the others. Clamp in position, and drill the two horizontally opposite holes through the side, using the oval as a jig. Fasten the manhole in place with two 10-B.A. screws and nuts, remove the clamp, and drill the remaining holes through. The plate may now be removed and put aside until final assembly, while we get on with the back.

Back and Bottom

The back and bottom of the tender could be made in one piece, but if made separately they will be not only easier to bend to shape, but also to rivet in place later on.

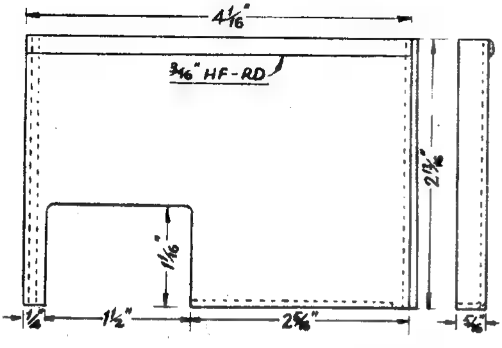
For the back you will need a piece of 18-gauge brass, $7\frac{5}{8}$ in. long $\times$ $3\frac{9}{16}$ in. wide, and for the bottom a piece about $5\frac{1}{4}$ in. long by the same width. This allows for a bit of waste to be trimmed off the ends when bending is completed; but if you aren't too experienced, you could allow $\frac{1}{8}$ in. more on each piece. It's easier to trim a bit of surplus off than to have to re-bend that reverse curve at the top!

This double curve is the most difficult, and should, therefore, be done first. The lower curve of the two is bent first. Tip—when bending curves such as this, mark a few pencil lines square across the work. Then by keeping these lines parallel to the mandrel as you work, you will ensure that the bend is also square across the work.

Anneal the sheet, and then grip it in the vice with a 1-in. bar as a mandrel placed about $1\frac{3}{4}$ in. from the top edge. Bend it round the mandrel, taking care not to bend the long piece to a curve—the palm of the hand should be flat on this part, with the edge of the hand close to the vice jaw,

so as to sort of push the metal over. Bend it slightly further than really necessary, as there is a tendency for it to go back a little when bending the upper curve in the opposite direction.

Use the flange of the tender-side as a templet for the bending, and when the lower curve is satisfactory, grip sheet and mandrel in the vice



The coal-plate is set at an angle across the tender, so the flanges are not at right-angles

for bending the upper curve. If you put a second piece of round bar in the hollow of the first bend, you can get a nice even pressure on, and in a sense "roll" the curve on. Come to think of it, that would, perhaps, be a good way of doing the first curve!

Get as good a fit as you can to the curve of the tender side, and then bend the curve at the bottom of the back. A larger mandrel is required here—I have accumulated a fair assortment of short lengths of steam piping of various diameters for such purposes, but the humble glass bottle is not to be despised if nothing else is handy.

Regarding the bottom of the tender, don't bother to bend this until the whole thing is being riveted together.

Tank-top or Footplate

The footplate is also of 18-gauge brass, with flanges $\frac{3}{8}$ in. deep on three sides as shown. The bend of these should be as sharp as possible, which means the sheet should be annealed first. Note that the total width, including flanges, is 4 in., and this is an important measurement, so that when setting out for bending the flanges, the distance between the bending lines should be 4 in. minus twice the thickness of the sheet, i.e., 3 29/32 in.

These flanges are best bent in folding-bars, sometimes called a bending-break. They may be improvised from two pieces of angle-iron gripped in the vice, or from two pieces of stout flat bar loosely bolted together at the ends. The plate having been placed between them, the bolts are tightened and the bars gripped in the vice, when the flange can be hammered or malleted over. To obtain an even bend, place a piece of hardwood, longer than the sheet, against its edge and strike on the wood, finishing off with lightish blows from the hammer alone.

Notice that on the right-hand side the flange is cut away for 1 in. to clear the water-filling pocket; but it should not be cut away until the flange has been bent. Again a tension-file is useful.

There are two holes in the tank-top: one for the suction-pipe and the other for the pump by-pass. The former has to be large enough to pass the filter at the end of the pipe, and thus is tapped $\frac{5}{16}$ in. $\times$ 40, while the by-pass hole is drilled 7/32 in. dia.

Coal-Plate

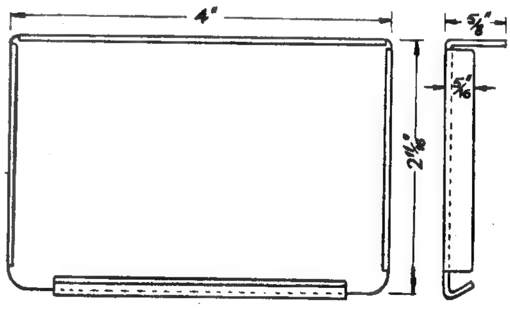
The coal-plate is placed at an angle across the tender, and, therefore, is $\frac{1}{16}$ in. wider than the tank-top, with the flanges slightly out of square. A third flange is formed on the bottom edge to stiffen it and to be soldered to the tank-top.

Cut the "coil-'oil" (as they say i' Yorksher) after forming the flanges. Oh, and talking of flanges, bend the bottom one first. Then the nearside one can be bent at the end of the folding-bars, removing one of the clamping-bolts for the purpose and gripping the end only in the vice—the plate will project downwards too far to get the lot in.

Front of Tank

The tank front is also of 18-gauge brass sheet, and since this is flanged on all four edges, you may prefer to make a hardwood former. The upper flange is $\frac{5}{8}$ in. wide, and the tank-top rests on and is riveted to the rear half of it, the front half supporting a separate small footplate which covers the space between tank and boiler back-head.

Since this sheet is flanged on all four edges, we can only do three of them in the folding-bars,



In the tank-front, note that the bottom flange is at an angle, and not square

starting with the top one, and then doing the sides as we did the nearside one on the coal-plate. The bottom one is turned over by gripping the plate in the vice with a short length of square or flat bar clamped to the line: it can then be hammered over at right-angles. After removing from the vice, the flange is carried further over by holding the plate flat on the bench and hammering as required.

(*To be continued*)

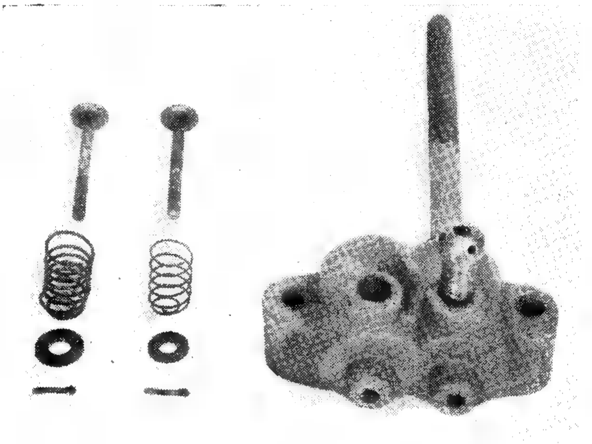
PETROL ENGINE TOPICS

*"New Engines for Old!"

How an Ancient Gas Engine was Improved, Modernised, and Given a New Lease of Life

by Edgar T. Westbury

APART from the fact that the old valves were by no means accurate in any essential respects, new valves were necessary because of the enlargement of the ports and seatings. In gas engine practice, valves were often made with mild-steel stems and cast-iron heads, and these gave better results than all-steel forged valves, unless special heat-resisting steels were employed. The latter is now almost universal practice for all types of i.c. engines, and although the special valve steels are difficult to obtain, a simple solution of the problem can be found in machining down old motor car valves. This was the method adopted here, a visit to a local garage providing a heterogenous selection of valves in various stages of decrepitude and dissolution, but practically all containing sufficient good material for our purpose.



The valve chamber in its original condition, showing ignition tube and valve assemblies

The valves were held by the stem in the lathe chuck, as close to the head as possible, and the surplus material roughed away, using a slow speed and fairly heavy cuts, as the burnt skin of the metal is not good for the lathe tools. Sufficient metal was left on the head to allow of putting in a centre which could be partially or completely faced off afterwards, and the rest of the head left slightly oversize for finishing. The stem was then extended from the chuck for a length sufficient to enable the valve to be machined all over at one setting.

It will be noted that in this method of machining a valve, it is not possible to "offer up" the stem for fitting it to the guide; it must be machined to measurement, preferably by micrometer, and if it doesn't fit when cut off—well, it's just too bad! But in nearly all cases it is possible to use a standard reamer to finish the bore of the guide, and in any case a piece of standard rod can be used, or turned to size, to serve as an extempore plug gauge. The method does, however, ensure that the stem and seating of the valve are concentrically aligned, and if the head is centred as suggested, it also solves the problem of steadying the very slender stem while turning, and the setting of the top slide for finishing the seating is rendered more convenient. The valve stems must be a close fit in the guides, particularly the inlet valve, where air leakage round the stem is fatal to good carburation, but there must not be the least trace of stiffness or "stickiness" in their motion. It may be observed here that no distinction has so far been made between the inlet and exhaust valves, as they are both the same size and made in the same way; their functions are interchangeable until the arrangement and timing of their operating gear is decided.

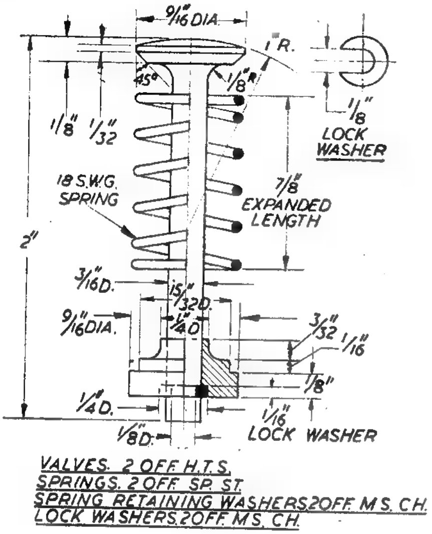
The original valves had the stems cross drilled, and the springs were retained by ordinary washers and *split* pins; neither scientific nor a sound arrangement. To improve upon this, the new valves had grooved stems to take a "horse-shoe" lock washer and a recessed collar long enough in the bore to keep the spring in proper alignment. While this method is not as strong as the split collet method now employed in most high-performance engines, it is easier

*Continued from page 852, Vol. 105, "M.E.," December 27, 1951.

to make and fit, and quite adequate for moderate duty. The retaining collar and lock washer were case-hardened to prevent burring or other damage encountered under working conditions.

Valve Caps

These were made of mild-steel, being of the conventional type once common in motor-car



practice, recessed on the top face and slotted or "castellated" to take a C-spanner, or similar type of key. The cap over the inlet valve was drilled and tapped for a ⅜ in. × 24 t.p.i. sparking-plug.

The machining of these caps from 1-in. mild-steel bar was quite straightforward, and calls for no special comment; the threads were, of course, screwcut, and a relief groove, down to the core diameter of the thread, was turned behind the shoulder to enable them to screw right home.

The slots in the valve caps were milled with the aid of a ⅛-in. slotting cutter, mounted in a simple milling spindle on the vertical slide, as shown in the photograph. The drive to this spindle was by means of a belt, from a motor mounted on a board which was clamped to the rear end of the lathe bed but as explained in the "M.E." handbook, *Milling in the Lathe*, there are many possible ways of driving the cutter, including the use of a hand crank mounted directly on the spindle. Indexing of the headstock was carried out with the aid of a change wheel and locking plunger.

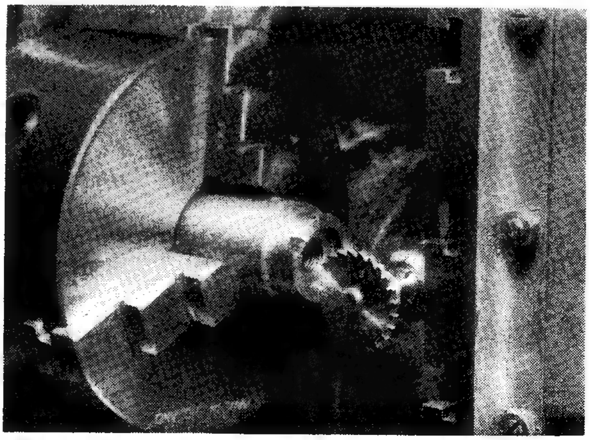
At first, some difficulty was encountered in getting a tight joint with these caps, especially in the case where the thread in the casting had been untrue. No standard copper-asbestos washers of suitable size were available; washers of asbestos jointing composition were unsatisfactory, being liable to split or squeeze out, and the use of a "grommet" or "plumber's joint" with asbestos string and joint varnish, though more or less effective, was too slovenly to merit consideration as a final solution. Eventually the problem was solved by obtaining an old copper-asbestos gasket for a motor-car cylinder-head, which had a hole of about the correct size, and cutting round this to produce a "pukka" copper-asbestos washer.

Compression Ratio

It may be observed that the machining of joint surfaces on the cylinder, valve chamber and body casting have all combined to increase the compression ratio of the engine. This was no disadvantage, as it happened, the original ratio being very low, but had it been considered necessary to do so, the best way to compensate matters would have been to shorten the connecting-rod, which is a better method than introducing packing plates between the cylinder and body.

Engines with "marine type" big-ends often had packing plates provided between the brasses and the foot of the rod to adjust compression where necessary.

The main object of such provision was to enable the engines to be operated at maximum efficiency on gaseous fuels of varying quality, such as "town" gas (i.e. normal coal gas), also different types of producer gas, blast furnace gas, natural gas, etc.; also, to compensate for differences of barometric pressure, such as were encountered when engines were installed at high altitudes, in mountainous regions. The rarefied air thus encountered, not only called for readjustment of air and gas ratio, but also produced the effect of lowered compression,



Slotting the new valve caps, which are screwed into a tapped piece of material held in a chuck

which could be at least partially corrected by increasing the thickness of the packing plates.

(To be continued)

IN THE WORKSHOP

by "Duplex"

No. 106.—*Making a Twist Drill Grinding Jig

THE grinding head illustrated was originally made for mounting on the lathe top slide, and for this purpose ■ square shank was fitted so that the tool could be securely held and correctly aligned. This shank, however, serves another useful purpose, as it is used for holding the head portion or body at centre height when the bearing housings are being bored exactly in line and concentric with the outside diameter.

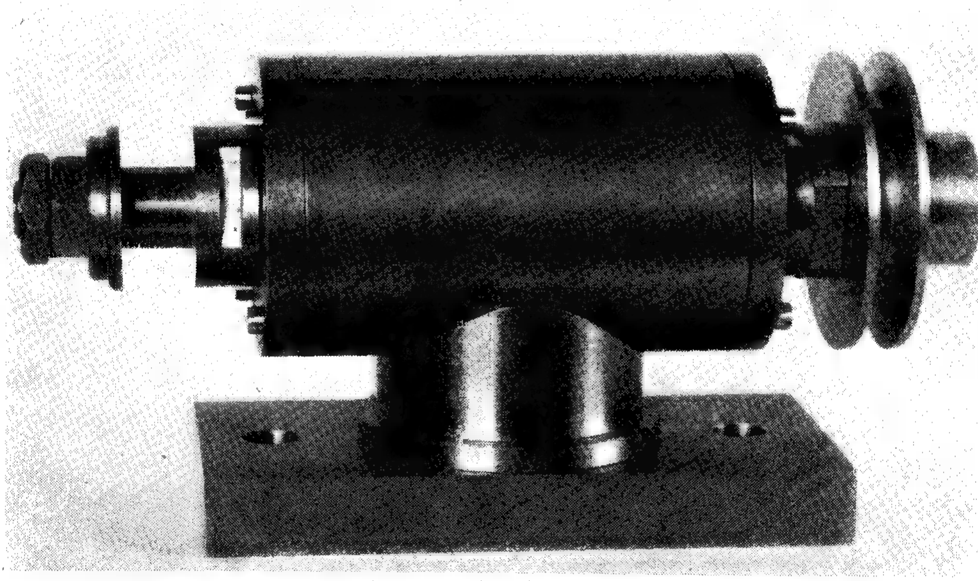


Fig. 44. *The grinding head*

The Body—(Part 1)

A short length of cored phosphor-bronze was selected for making the body; this was turned parallel, the two ends were faced, and the bore was cleaned up to give clearance for the spindle. Next, the square shank was screwed firmly into place against ■ shoulder, and a cross taper-pin was put in to secure the parts in place. When fitting the shank to the body, the long axis of the head must, of course, be set parallel with the flat on the under side of the shank; this can readily be done on the surface plate with the aid of the test indicator. The shank can now be mounted in the lathe toolpost, and, where necessary, packings are added to bring the centre-line of the body to lathe centre height. The body can be set parallel with the lathe axis by means of ■ try-square resting against the chuck face. The setting is finally checked with the test indicator mounted in the mandrel chuck, so that readings can be taken at intervals of 90 deg.

With the work correctly centred on the lathe axis, the bearing housings are machined with ■ boring bar running between the lathe centres.

For the boring operation it will be found more convenient to use a bar carrying two cutter-bits, spaced apart an inch or so more than the overall length of the body. When the first housing is nearing its finished size, a reading is taken against the cutting edge of the tool with the test indicator. For this purpose, the test indicator is mounted on the pillar of the surface gauge with the base resting on the lathe bed; at the same time, the base register pegs are pushed down and make

*Continued from page 861, Vol. 105, "M.E.," December 27, 1951.

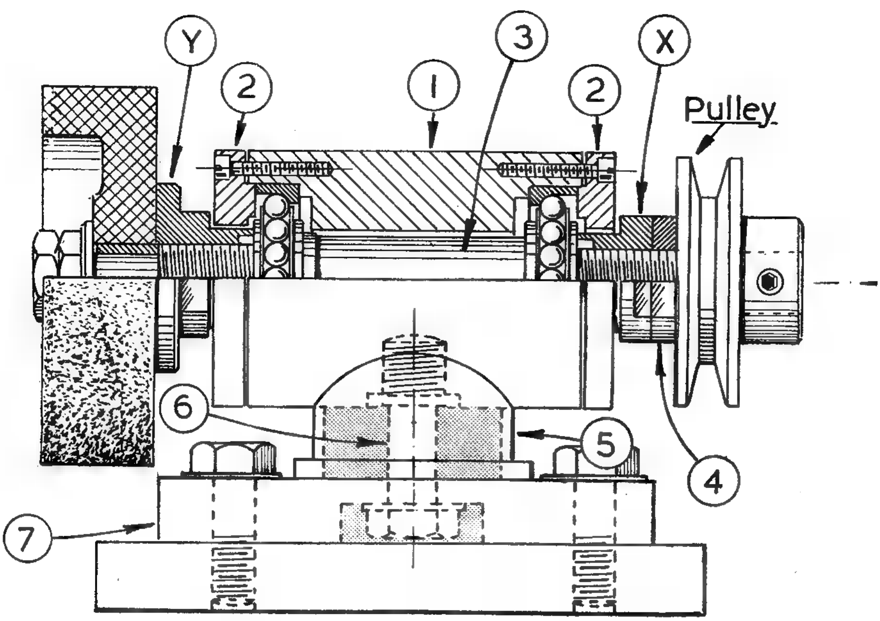


Fig. 45. Details of the grinding head. (1)—*the body* ; (2)—*end plates*; (3)—*spindle* ; (4)—*locking collar* ; (5)—*saddle* ; (6)—*draw bolt* ; (7)—*baseplate* ; " *X* " *and* " *Y* "—*bearing clamp-collars*

contact with the guide surface of the bed shere. If a micrometer reading is now taken in the housing, the tool can be set with the aid of the test indicator to machine the housing to the finished size.

Moreover, by moving the test indicator along the bed, it can be employed to adjust the other cutter-bit to machine the second housing to the same size. Both ends of the body should be faced square with the housings by taking a light scraping cut with each tool-bit in turn before the work is removed from the lathe.

The bearings should be made an easy push fit in their housings, as any tendency to rotate is checked by the pressure plates fitted at either end of the body. Remember that the two ends of the central bore must be enlarged to enable the outer ball-races to be withdrawn when required.

The Ball-bearings and Spindle —(Part 3)

The bearings chosen were a pair of Hoffman magneto-type ball-bearings, having a bore of 16 mm., as these will carry both radial and thrust loads.

The manufacturers state that these bearings are suitable for light loads and can be run at very high speed, but it is important to make sure that the axial adjustment does not throw any permanent load on the balls.

As will be seen in the drawing, the left-hand inner ball-race is located by being securely clamped against a shoulder, but the corresponding right-hand race is made an accurate sliding fit on the spindle so that the necessary adjustment can be made to eliminate end-float. To obtain a close sliding fit for the right-hand inner race, the spindle may with advantage be lapped so as to form a smooth surface that will not suffer wear by the race being removed at times during the course of construction ; a surface with a turned finish, on the other hand, will probably show minute ridges, and when the crests of these turning marks have been worn down the race may then be a slack fit. The mild-steel spindle is turned between centres, and it is advisable to screw-cut the threads to ensure accuracy. It should be noted that two small flats are filed on the right-hand end of the spindle ; these enable the spindle

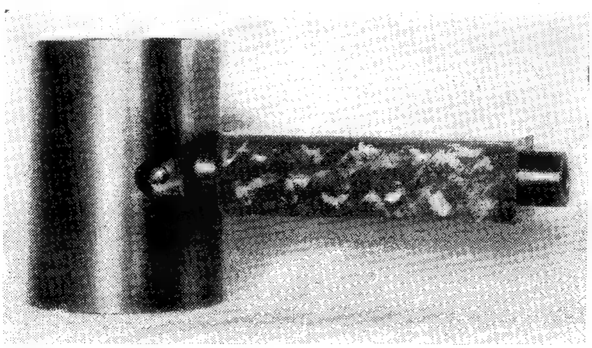


Fig. 46. The body mounted on its temporary shank

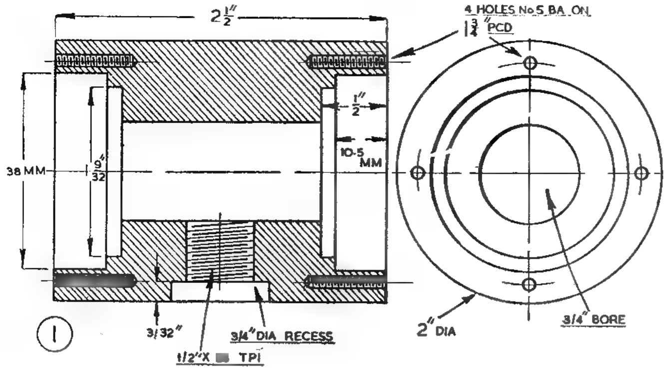


Fig. 47. Sectional view of the body and bearing housings

to be securely held, either in the vice or by means of a spanner, when making the bearing adjustment or clamping the grinding wheel in place.

The End Plates—(Part 2)

These clamp the outer races of the bearings securely in their housings, and they can be machined by [redacted] straightforward turning operation; it is, however, important to make the central bore concentric with the register shoulder so that, to form an efficient grease and dust seal, only a small clearance is left between the bore and the bearing clamping collars.

As will be seen in the drawing, the end plates [redacted] shown secured with four 5-B.A. screws, but this number might well be increased to six.

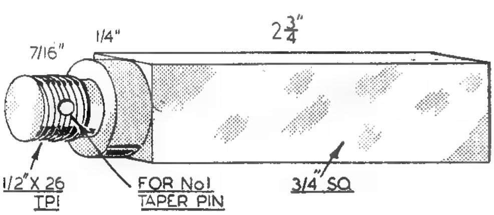


Fig. 48. Showing the dimensions of the body shank

The Bearing Clamp Collars—(Parts X and Y)

These collars are turned from mild-steel bar, and it is important that the internal threads should be accurately cut so that even contact is made against the inner bearings races. The left-hand collar is made of larger diameter to provide [redacted] clamping surface for the grinding wheel and, although not shown on the drawing, the face of the collar should be recessed to give [redacted] better bearing for the wheel; moreover, when this is done, the bearing can be assembled on the spindle and [redacted] light truing cut taken over the clamping face of the collar with the work mounted between centres.

The Spindle Bush for the Grinding Wheel

The end portion of the spindle on which the grinding wheel fits has the threads removed by reducing its diameter to 3/8 in. But as the bore of a standard wheel of the type fitted is 1/2 in., [redacted] bush is used for mounting the wheel. This bush can either be made parallel, as shown in the inset drawing in Fig. 51, or [redacted] flanged bush of the form illustrated in Fig. 52 can be employed. Where both coarse and fine wheels are mounted separately on the spindle for grinding large and small drills, it is, perhaps, better to fit the individual wheels with the flanged type of bush, for there is then no danger of looseness developing as [redacted] result of the frequent interchange of the wheels. It is important that the bush should not be [redacted] tight fit in the wheel bore, as this will throw [redacted] bursting strain on the wheel, especially if the spindle becomes heated, as it may in a grinder fitted with plain bearings.

Where [redacted] flanged bush is fitted, the length of the collar (Y) will have to be reduced somewhat or the shouldered portion of the spindle lengthened. In case the reference to using both coarse and fine wheels may lead to a misunderstanding, it should be pointed out that in actual practice a wheel of medium grit-size has been found quite satisfactory for grinding drills ranging from No. 60 to 1/2 in. in diameter, and it is only when small drills predominate, and larger drills are only occasionally ground, that it is worth while using two kinds of wheels.

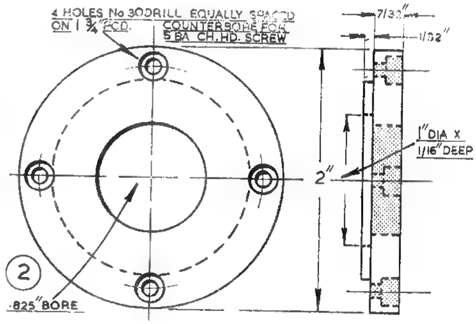


Fig. 49. The end plates for clamping the bearing-races

The Pulley and Driving Belt

To get lasting wear, the pulley is best made of cast-iron, but mild-steel will serve quite well for this part. The pulley groove is machined to an included angle of approximately 30 deg. to take [redacted] $\frac{3}{16}$ in. diameter sewing-machine belt, and the pulley itself is made to screw on to the end of the spindle, where it may be secured by means of a 2-B.A. Allen grub-screw fitted in the floor of the groove. A rather better appearance is obtained, and the fixing will be more secure, if the pulley is made with an extended nose to

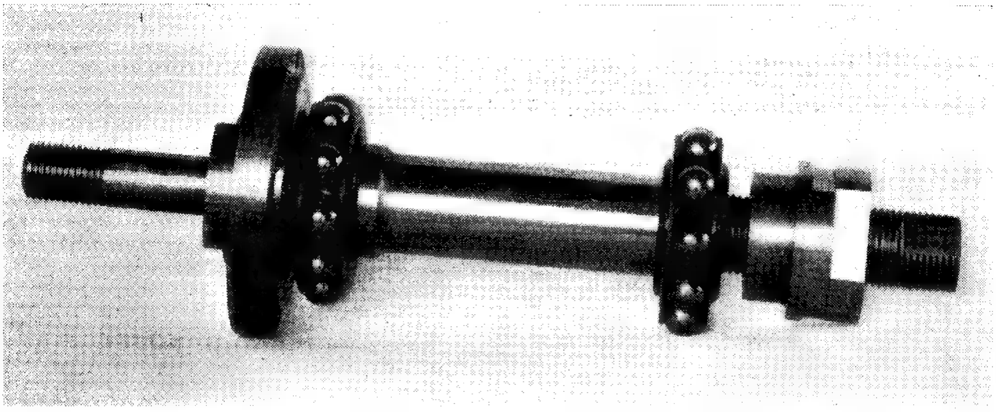


Fig. 50. The spindle with its collars and bearings

carry the locking screw, or as shown in the drawing this nose may take the form of a separate, threaded collar. Sewing-machine belts are supplied with ■ U-shaped fastener that is ■ little too heavy for the present purpose, and the ends of the belt will be less liable to bulge or to tear if the fastener is made of 18-gauge cycle spoke.

(*Continued on page* 62)

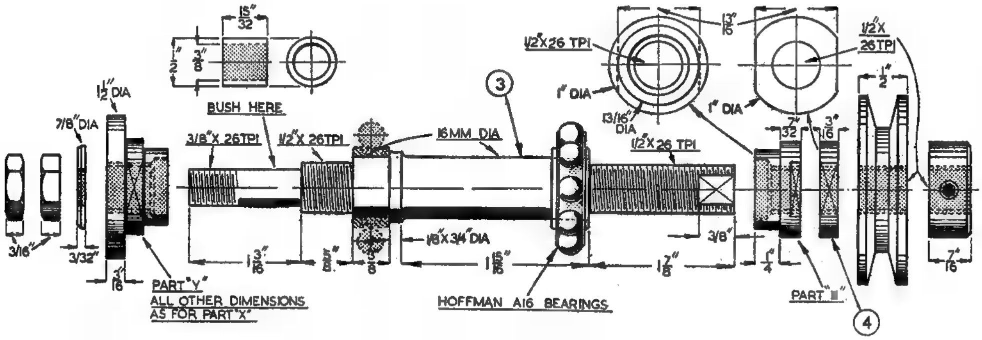


Fig. 51. Showing details of the spindle and its fittings

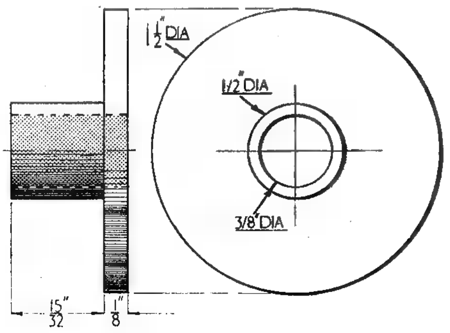


Fig. 52. The flanged wheel bush

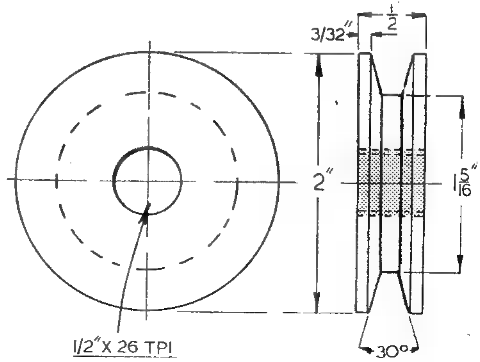


Fig. 53. The driving pulley

*TWIN SISTERS

by J. I. Austen-Walton

Two 5-in. gauge locomotives, exactly alike externally but very different internally

WE come now to a whole group of parts comprising the weigh-shaft, bearings, lifting-links, etc.; only the reach-rod and pole reverse being left to complete the entire valve set. If we care to exclude the drain cocks and its mechanism, which might be classed as an extra for a locomotive with slide-valves, then the completion of the first-named parts, marks the end of the chassis as a job.

There are two general views of the gear, the first being a plan view and the other a small scrap section in elevation, mainly to show the position of the bearings in relation to the motion-plate. The bearings were prepared in casting form in the very early days, and are readily available; now that they have been made up and machined, they look exactly as they should. Although it is not mentioned, the bearings are split, exactly as correct plummer-blocks are made, but builders of "Minor" can treat these as plain bearings if they wish, and may omit the studs and nuts as well, unless they want these for pure ornament.

Less Filing

To make up, take the castings, cleaning off sand, pips, etc., in the usual way, and machine or file the base quite flat. Machine or file the ends to the finished overall dimension, and scribe off the ½ in. centre-line. Next, drill for the studs with 10-B.A. tapping size, carrying the drilling well down, following on with a spot-facing tool on the cap of the bearing, to provide a neat and true seating for the nuts. If you have decided to have the split bearings, carry out this operation *next*, using a very fine slitting saw in preference to a hacksaw. Even the "Junior" type of saw blade takes rather a lot away from such a small part, and subsequent filing of both halves will make matters even worse, and you will finish up with a bearing that looks far too "squat." I use a ten-thou. saw in the lathe or milling machine which leaves a finish that does away with any filing.

When this operation has been carried out, it is a good plan to open up the holes in the caps to clearing size, to tap the holes in the main body, and fit studs and nuts right away. There may be some slight differences in the caps (you know what castings are like these days) and you will not lose the parts cut off.

The scribed centre-line will now be the joint, and a tiny pilot hole can be drilled right through from each side, following on with larger drills, finally reaming out to 7/32 in.

The next step is to clean up the long sides of the castings, after which you may carry out a "de luxe" operation if you wish. This consists of setting up the bearing on a piece of 7/32 in. rod with a scrap of very thin foil pinched in between the rod and the bearing cap, so that when the rod is set in the lathe it will drive the whole lot as a solid piece. If the free end of the rod is centred and supported by the tailstock of the lathe, you will be able to turn down the two ends of the bearings to give the back relief clearly shown on the drawing, and to simulate the projecting brasses usually associated with the plummer-block type of bearing.

The fixing holes for the bearings are shown, the size being 8-B.A. clearance. The fixing set-bolts for these will have to go into tapped holes in the top plate of the motion-plate; a brief examination will show that any other form of fixing will not allow access for putting on any nuts underneath. However, there will be ample strength in the sizes and provision made.

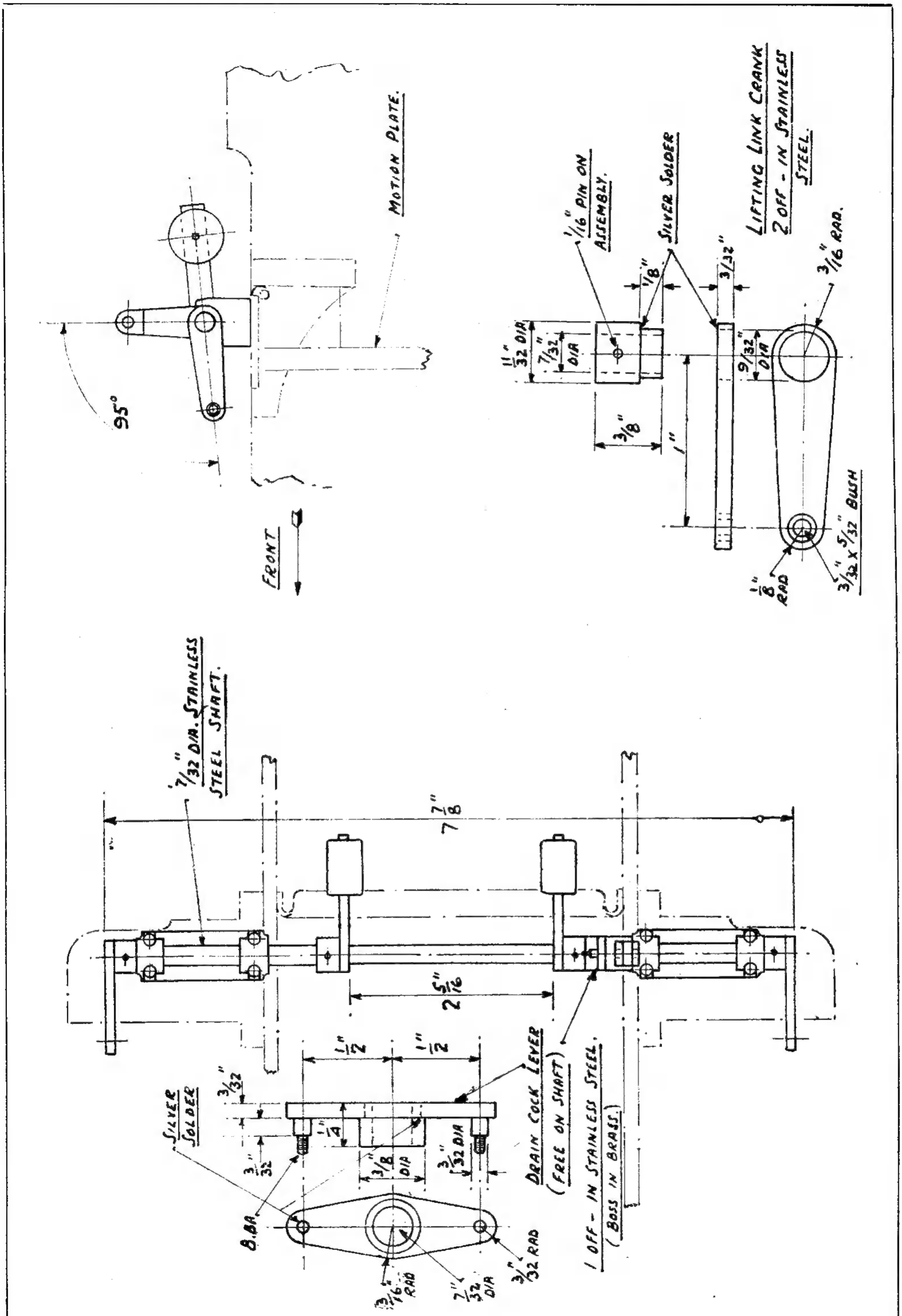
The weigh-shaft is just a plain piece of 7/32-in. stainless-steel rod; ¼ in. would do, although it would actually be much over scale, but the steel supply position may make its use imperative. The rod should not be cut to final length until all the other parts are made, just in case of error.

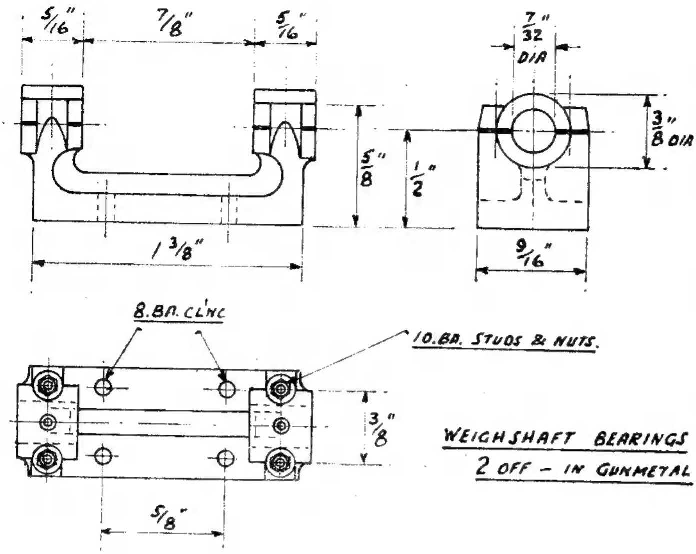
Tiny Jobs

The lifting links, which are the only parts not shown assembled, are probably the only parts that will take much time to make; these tiny things with two fork-ends usually do. The other cranks and fittings, all of which go inside the bearing blocks (lifting link cranks excepted, of course) are made from plate material fitted on to simple turned bosses. The reach-rod crank has a single fork on it which, in itself, is unusual; one generally finds the reach-rod has the forked end, but in this instance I have changed the order of things on purpose. It is much easier to make a short crank with a forked end, all out of the solid, than it is to improvise a long reach-rod with a built-up fork that has to be brazed, silver-soldered, pinned, cleaned up and what have you. When I built *Centaur* I never thought of this dodge, and hacked the entire reach-rod out of a piece of ⅝ in. dia. stainless rod, just in order to leave a solid fork at one end; flat stock was unobtainable in those days, and it would have been nearly as much work if I had been able to get it.

The order of assembly should be as follows: just in case the drawing isn't sufficiently clear. Ignoring the lifting links we have a lifting link crank, one of the bearing units, the reach-rod crank, hard up to the bearing inside; the double-ended crank for the drain cock operation, and running *loose* on the shaft, followed by one of the counterweight cranks. The other

**Continued from page 856, Vol. 105, "M.E.," December 27, 1951.*


MOTION PLATE.
95°
FRONT
1/16" PIN ON ASSEMBLY.
SILVER SOLDER
LIFTING LINK CRANK
2 OFF - IN STAINLESS STEEL.
3/16" RAD.
3/32" x 5/32" BUSH
1/8" RAD
7/32" DIA. STAINLESS STEEL SHAFT.
7 7/8"
2 5/16"
SILVER SOLDER
DRAIN COCK LEVER
(FREE ON SHAFT)
1 OFF - IN STAINLESS STEEL.
(BOSS IN BRASS.)
8 BA.
3/32" RAD



WEIGHSHAFT BEARINGS
2 OFF — IN GUNMETAL

side is exactly the same, less the drain cock unit.

When the crank bosses are made, the cranks may be assembled on them and the turned-down portion, which should project a little way through the crank, lightly riveted over. Carry out this operation so that the crank can still be turned stiffly on its bush or boss. Now put the whole assembly together, ignoring for the moment any surplus shaft sticking out at either end. Put the lifting links in place, coupled up to the radius-rods of the motion.

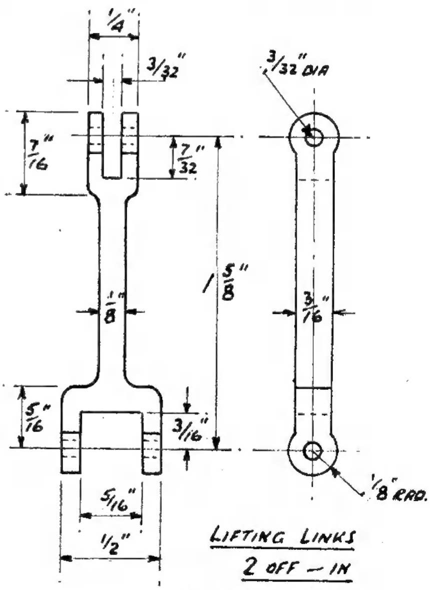
The first thing is to pin the crank bosses to the shaft, after which the cranks may be turned on the bosses so fixed until you get absolutely even lift to both sets of motion; for example, when in mid-gear, you should be able to turn the wheels without any movement being derived from the radius-rods, that is, fore and aft.

Check also that forward and reverse positions agree entirely, after which the cranks may be unpinned from the shaft, *without disturbing their settings on the bosses.* Silver-soldering each crank in position will be an easy operation, and with the certain knowledge that, when reassembled, the positions will be dead right. I have always felt that trying to pin finished cranks to a nice smooth and slippery shaft, was a dodgy operation, and there seemed to be no certain way of clamping all the cranks in position in such a way that the drill, on breaking through, didn't wiggle them a little one way or another. After silver-soldering, the burred-over collar projecting, should be filed or turned off to leave a neat and clean job.

Another Problem

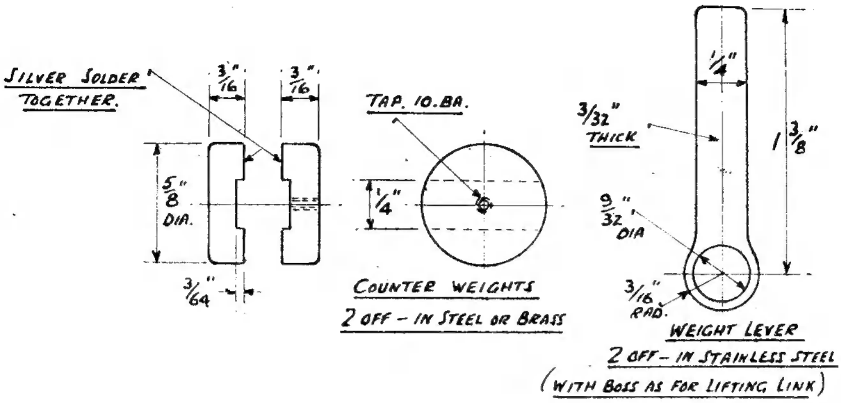
The counterweights are another interesting problem, and the method shown is just *one* way of doing it; you could also make the weights in one piece, drilling a single transverse hole through each, and using one of the well-known tension files to work the hole into the required slot.

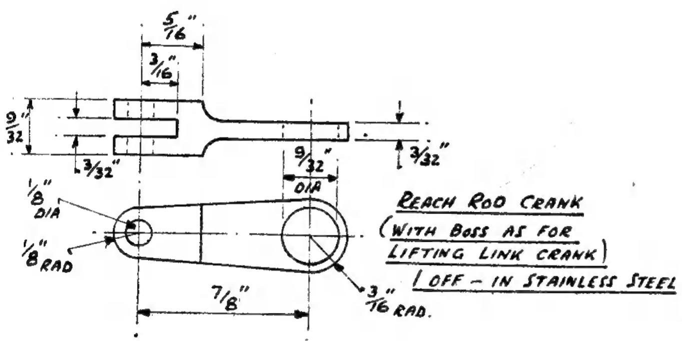
The double drain cock crank also has alternatives; apart from the fact that it is free to rotate on the shaft, this part could have a steel boss bushed with brass or other bearing metal, but apart from the actual look of the thing, the working advantage would be questionable. As a matter of interest, the top half of this crank embraces a rod that runs straight back to the cab—almost alongside the reach-rod. Both of these will be well out of sight in any case. The lower end of the crank will take a sharply set rod which will run down and across to the centre-line between frames, and through the round opening in the No. 2 stretcher and so on to the drain cock system. Whether you decide to use the four-cock system or the single valve, the rod approach is the same in both cases. No joint pins have been drawn; these I can leave to you, or you can repeat the type given in former issues for motion work. I think it would be as well to have the bolted-up type, as all the joints are accessible and it does make things



LIFTING LINKS
2 OFF — IN
STAINLESS STEEL.

easier when servicing is done. Notice also that the weigh-shaft bearings sit directly on the motion plates, and not on the footplate that is yet to come. The footplate will be in two pieces; the longer or after portion of which will be somewhat permanently fixed under the side tank,





whilst the forward part will be so arranged that it will not be necessary to unship half the valve-gear before removing it.

This means that the after footplate will be cut *round* the outside of the weigh-shaft bearing whilst the necessary slot to allow the lifting link to pass through to the gear below, will be open-ended when that section of the footplate is lifted for removal. With everything in the fixed position, the footplate will appear to be continuous and with the conventional slot for the lifting link, and little more than a tiny hair line to denote a join in the valance angle underneath.

Final Note

Painting folk please note. Shaft, cranks and links left bright. Bearings black, with turned ends to simulate brasses, left bright. Balance weights black. The set-bolt holding balance weight to arm, has a *square* head.

(To be continued)

In the Workshop

(Continued from page 58)

An alternative method is to scarf the ends of the belt and make a cemented joint ; this may be followed by stitching the full length of the joint with waxed thread to keep the ends from opening out.

This completes the essential work on the grinding head itself, but before final assembly the ball-bearings should be lightly packed with thin grease of the kind made for use in ball-bearings.

Further lubrication will not then be needed for a long time, and when this is due the head can be dismantled for cleaning as well as for lubrication. As an alternative, greasing holes can be drilled in the end plates to allow a gun to be used to feed the grease directly to the ball tracks, but these grease-ways must be closed with a grub-screw to prevent the entry of grit into the bearings.

As already pointed out, on no account must any permanent end-load be put on the bearings when adjusting the right-hand spindle collar, but after the adjustment has been made and the locking collar tightened, the spindle should revolve freely and be just free from end-float and radial play.

(To be continued)

PRACTICAL LETTERS

Old Steam Engines

DEAR SIR,—It is pleasing to note that, according to the letter from Mr. W. B. Stocks of Huddersfield in THE MODEL ENGINEER, dated November 1st, 1951, yet another old steam engine is to be preserved. No doubt Mr. Stocks has good reason for suggesting 1850 as the probable date of the engine's construction. I am, however, informed by Mr. R. W. Wood of Leeds that the four-spoked flywheel normally belonged to a much earlier period of engine building.

Mr. Stocks states that the oldest horizontal engine to be preserved is in the possession of the Clay Cross Co. I assume this refers to the one which was exhibited by that company at the Stephenson Centenary Exhibition in Chesterfield in 1948. The catalogue issued at that exhibition states that the engine worked from 1841 to 1946 at the Ambergate Lime Kilns; it does not, however, indicate whether the date of construction was 1841 or earlier.

Up to a few years ago, at least, the horizontal winding engine of the Swannington Incline was still working. This engine, according to a very detailed article on the Leicester and Swannington Railway by Mr. Chas. E. Lee in the *Railway Magazine* for July 1939, was completed about the end of August, 1833, by the Horsley Coal & Iron Co. of West Bromwich; there is also an article in THE MODEL ENGINEER dated June 23rd, 1932, concerning it. I am under the impression that this engine is being preserved—although I examined it in 1948, I have no up-to-date information as to its fate—and this would appear to make the engine about which Mr. Stocks writes the third, and not the second, oldest horizontal engine to be preserved in this country. It would appear quite probable, too, that the Swannington engine is older than the one possessed by the Clay Cross Co.

Yours faithfully,

Wakefield. DONATI O. WHITEHEAD, M.I.I.S.

Steel Boilers

DEAR SIR,—The Leamington & District M.E. Society having no track of their own, had the good fortune to meet a Mr. A. Reynolds, of Longbridge Manor, Warwick, who lent us 360 ft. of 5 in. track and wonders above all! a 5 in. Pacific and "Plain Jane" which he built and you published an article on in THE MODEL ENGINEER dated December 22nd, 1932.

Both these engines have steel boilers, welded at his own works and, believe me, work as well now as in the days when new, the Pacific worked an eight-hour day non-stop during the Society's show carrying 300 odd passengers, driven by chaps like myself to whom locomotive driving was a completely new experience.

From what one could see of the inside of the boiler, there is little dirt, etc., on or under the tubes, the amount of water needed to fill the gauge and the boiler was almost two gallons. So from my experience with her, I am fitting a steel boiler on my own "King" $7\frac{1}{4}$ in. gauge.

Yours faithfully,

Leamington Spa. C. W. A. SURRIDGE.

Curved Flywheel Spokes

DEAR SIR,—It is perhaps with some temerity that one essays "to break a lance" with your noted contributor Edgar T. Westbury, but I do feel that his remarks on flywheels, in the issue of December 13th, 1951, call for some comment. It is clear that the direction of stress in the spokes due to contraction will depend on which cools first, the rim or the boss. His statement would imply that a compressive stress only is induced by contraction of the rim. The reduction of diameter in a wheel casting is an extremely problematical matter to forecast, since the greatest contraction will be a linear one measured circumferentially. Again, this relative cooling will depend on the volume of metal relative to cooling area: consider the normally "square" section rim of an i.c. engine flywheel as against the comparatively light section rim of an old mill engine flywheel, particularly if the latter be designed with a broad face to carry V-rope grooves for driving.

In actual practice the moulder arranges the runner, or pouring-gate, on the boss of the wheel which practically ensures that this portion cools last, and consequently it can be taken that stress induced in the spokes will be of a tensile nature. If it were compressive, as your contributor's remarks would imply, we should—under working conditions, with the tensile loading due to centrifugal force—arrive at the highly satisfactory condition approximating to *no* stress in the spokes, something akin to the "auto-frettage" principle in making gun barrels.

To relieve this tension in the spokes of straight-armed flywheels they have been cast with solid rims and split bosses, since it is a fairly simple matter to machine out the split and pack before boring for the shaft journal.

Dealing with the spokes themselves, it is usual to consider these as cantilevers fixed at the boss and subject under working conditions to normal bending stresses. Clearly these stresses will alternate according to whether the engine is driving the wheel, or the wheel driving the engine.

I fully agree, as stated, that curved spokes were adopted, perhaps for ornament, but largely —by increasing the actual length of spoke for a given diameter of wheel—to permit slight "spring" and consequently relieve these stresses in part.

It is perhaps significant that curved spokes were essentially heavy gas and oil engine practice —never to be seen in old steam engines. Another instance which occurs to my mind is the type of hand-cum-flywheel fitted to chaff cutters and such agricultural machines; these wheels of light section throughout but of relatively large diameter, usually with oval rim section, were, I think I am right in saying, invariably made with curved spokes for casting reasons.

In conclusion, I need hardly say, I trust that these criticisms will be accepted, as they are intended, to be helpful on what, after all, is an extremely controversial subject.

Yours faithfully,

Leicester. H. W. M. BECK.